THE ANIMAL KINGDOM

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ANIMAL KINGDOM

THE STRANGE AND WONDERFUL WAYS OF MAMMALS, BIRDS, REPTILES, FISHES AND INSECTS. A NEW AND AUTHENTIC NATURAL HISTORY OF THE WILDLIFE OF THE WORLD.

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BOOK I: Mammals of the Air, Land, and Waters of the World

GEORGE G. GOODWIN

Continued from Volume I

Porkers and River-Horses — Pigs, Peccaries, and Hippopotamuses

HAVE YOU EVER OBSERVED a pig's snout? It is more remarkable than might be supposed from a casual glance. The snout acts as a combination steam shovel and bulldozer—it is used to lift and push weights, to dig, and to break through tangled brush.

Such tasks call for an exceptionally durable organ, and the pig's snout answers that description well. At the end of the long, flexible muzzle the nostrils open on a tough, flat, mobile, disklike plate. This is reinforced within by gristle attached to the skull.

As for the pig's mouth, it is noteworthy for the razor-keen tusks in particular. Usually—not always—the pair in the upper jaw are larger and curl upward. They are kept sharp by the honing action as they rub against the tusks of the lower jaw.

Wild pigs are mentally alert and decisive in action. The ground is their native element—they don't climb trees; however, they can swim. They are sociable and love company. Living in forests or bush country, they depend largely on roots and tubers for food. But they also eat small animal life, fruits, nuts, berries, and the like.

Pigs are creatures of temperate and warm regions. We find them well distributed over the Eastern Hemisphere, including Madagascar, but not Australia. In the Western Hemisphere, the hog family is represented by the peccaries.

Extinct pigs, some of them gigantic, lived in Europe during the Pliocene age, which ended over a million years ago, after lasting about eleven million years. Man tamed some of their smaller descendants at an early date; in China, we have found bones of domestic pigs in New Stone Age sites, and the chances are that the Chinese domestication of the pig goes back well into prehistoric times.

Among domestic pigs, the Razorback Hogs of the southeastern

United States and the Diving Pigs of the Florida islands have reverted to the wild type; and we find such "feral" pigs on many of the islands of the West Indies as well.

In the old days of sailing ships, salt pork was an important item on the menu of any vessel. The flesh of the pig absorbs salt more readily than most other kinds of meat and can therefore be preserved longer. Then, too, it is a plentiful and inexpensive kind of meat, for pigs are great breeders. Domestic sows may have as many as two, and sometimes even three, litters of young in a single year. The piglets may number anywhere from eight to twenty-two, and it is to be noted that the sow has more teats than any other animal—she may possess up to twenty-eight. Among the wild pigs, too, some types tend to large families.

WILD PIGS OF EUROPE AND ASIA

THE EURASIAN WILD BOAR—IT PITS ITS STRENGTH AGAINST MAN'S

The Eurasian Wild Boar, *Sus scrofa*, is a rugged, sinewy creature. It is a forester, and is especially useful in breaking up the tangled mass of roots and excess growth on the forest floor and freeing timber from the stranglehold of vines and brush. Another way in which this animal is of great value is that its bristles are manufactured into the finest utility paint brushes.

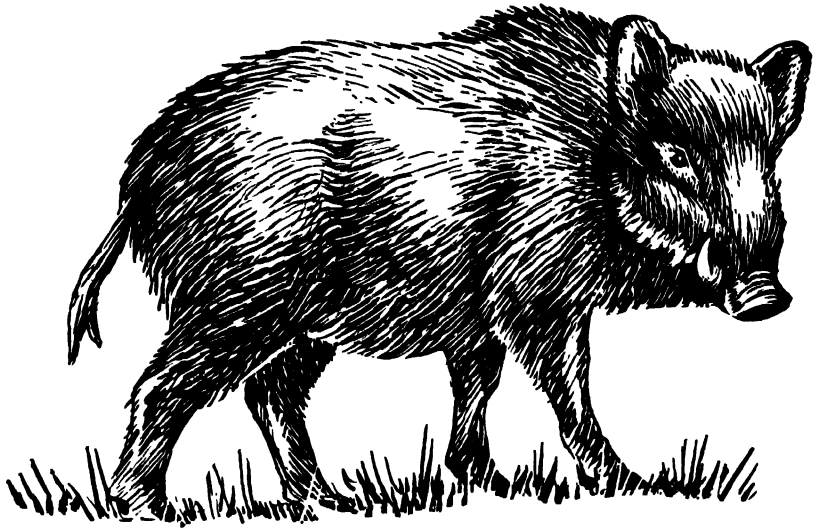
That, of course, is a far cry from the living animal. The Eurasian wild boar, in life, presents a most impressive appearance. It is the largest of all the wild pigs. Standing over three feet at the shoulder, it has a head and body length of almost five feet; a large boar weighs 550 pounds, sometimes even more. In color it is dusky or grayish brown. Its coat is made up of long, coarse, black hair that overlays the thick, woolly, yellowish-brown underfur. The large, sharp, strong tusks may be almost a foot long.

(The word "boar," by the way, is apt to prove confusing, as it can be employed in two senses. We say of all pigs that the male is a "boar" and the female is a "sow." But the term "wild boar" refers universally to a species, male and female, and that is the way it is used here.)

Boar-Hunting—a Popular Sport. Hunting the Eurasian wild boar with spears and dogs was an immensely popular sport during the Mid-

dle Ages, and it flourished in England. In some parts of Europe and India the pastime still lives on today.

Courageous and ferocious when held at bay, this magnificent animal is more than a match for a whole pack of hounds. It will unhesitatingly charge a hunter mounted on horseback, and many a sportsman has been seriously scarred or killed in a desperate encounter with one of these diehard fighters. Old English writers referred to the sport with justice as "a verie dangerous exercise."



OBJECT OF MANY A THRILLING HUNT

Before the age of guns, hunting the European wild boar was a great and dangerous challenge to hunters. A fierce and fearless animal, the wild boar would turn and charge both the mounted huntsman and his horse, often wounding or killing them. Today, the wild boar can be easily shot down. The animal has its practical uses—its strong, stiff bristles end up in paintbrushes.

Because of the hazards involved, killing the wild boar ranked as a deed of chivalry during the Middle Ages. The animals, which are recorded as living in the neighborhood of London in 1174, continued to be numerous in England until the improvement in firearms made it comparatively easy to kill them.

It was the custom for a pack of hounds and men mounted on horseback to take part in the chase. Brought to bay, an old-stager would rush its assailants with great ferocity, and was almost certain to wound one or more of the dogs. The horses were also likely to be

ripped about the legs and their riders thrown to the ground; then the infuriated beast would charge the unfortunate horseman before he could rise. In such crucial instances the punctilio of the sport permitted the use of firearms. (The orthodox manner of ending the hunt, if all went well—for the hunters, that is—was for one of them to plunge his knife in the throat of the charging boar.)

That the killing of a wild boar is not always a quick and sure job, even when guns are used, the author has seen for himself. Once, when he was in Iran, camping on the shores of the Caspian Sea, a native sent a runner asking for help in getting rid of a wild boar that was devastating his vegetable garden. (Being a Mohammedan, the native could not slay the animal himself.) After driving about twenty miles, the author came to the man's cottage at dusk and shot the animal, which seemingly fell dead.

The big boar was loaded onto the front bumper of the writer's car and he and his party began to drive back to their camp in the dark. Imagine everyone's amazement when suddenly the stillness was rent by a hair-raising scream that came from somewhere in front of the radiator. It took a few seconds to realize that the "dead" boar had all of a sudden come to life. The next few minutes were hectic, but the maddened animal was finally subdued.

Boar's Head and Roasted Sucking Pig. The killing of a wild boar and the serving of its head at Christmas in Merrie England dates back to the ancient custom of making a boar offering to the goddess Freya at the winter solstice. In those days, people worshiped the boar as a symbol of fertility of the land, and hunted and killed it with colorful pageantry. The English custom of eating a roasted sucking pig on feast-days is a survival of these ancient ceremonies.

A Prolific Breeder. The Eurasian wild boar is prolific; there are likely to be two litters a year, with four to six babies in each. After mingling with the sows during the mating periods, the males then separate into small bands by themselves. When "pigging" time comes, the sow—she is now described as being "in farrow"—makes a fairly comfortable den in the thick brush. The young, though small at birth, are quite active; they are brown in color, with lengthwise dark stripes and spots.

Once the offspring are old enough to travel, the groups of sows and

their young (known as "sounders") join company. By the time that the acorns begin to fall in autumn, there is a general migratory movement to groves of oak trees. In Iran, at this time of the year, the hillsides are often black with teeming herds of wild boars.

Originally the Eurasian wild boar roamed over all the forested parts of Europe, east across Asia and Siberia to the Pacific coast, and south into North Africa. As with most animals that are spread over an extensive range, the wild boar varies quite a bit in appearance, depending on the localities where it flourishes.

INTERESTING WILD BOARS OF THE EAST

The Soor, Indian or Crested Wild Boar, *Sus cristatus,* is the common wild pig of India. Formidable when aroused, it has been known to kill a tiger. It stands almost three feet at the shoulder and weighs about 250 pounds. A distinct crest of long, stiff, black bristles extends from in back of the head down the neck to the shoulders.

Like its northern relative, the crested wild boar lives in the forests and builds a nest of leaves and sticks for raising its offspring.

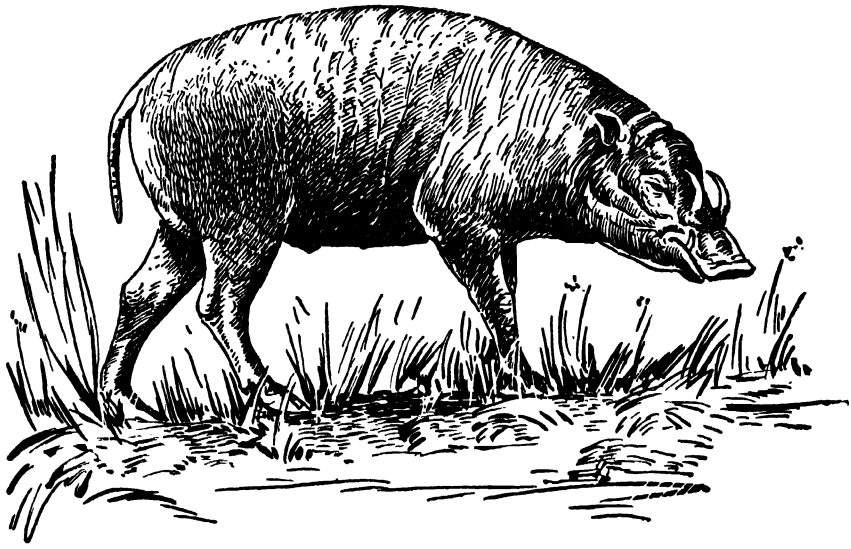
The Babiroussa, or Celebes Pig Deer, *Babirussa babyrussa,* is not considered a true pig. However, it does belong to the hog family, and not to the deer family as one of its names implies.

A strange-looking, unlovely creature, the babiroussa is almost completely devoid of hair, and the bare gray skin is lined and heavily wrinkled. The whole animal appears to be wedge-shaped, but in reverse, tapering down evenly from the high hindquarters to the low shoulders and the snout of the pointed, relatively small head.

The most remarkable feature of the babiroussa is its weirdly shaped tusks, which run to as much as seventeen inches in length. In the upper jaw of the male these teeth, instead of projecting outward as in most other pigs, rise straight upward, piercing the skin of the upper lip, then turn backward in a sweeping curl; they may even reach the forehead! The lower tusks are shorter and more slender. Such fantastic tusks seem to be of little or no use to the animal and are a mere "sport" of nature.

The Celebes babiroussa is a herd animal with the habits of most wild hogs. It dwells in jungles and woodlands, preferably in locations near water, since it is an excellent swimmer. This wild swine, which

stands somewhat over two feet at the shoulder and weighs a bit over 125 pounds, has frequently been domesticated by native tribes.



FREAKISH TUSKS WITHOUT PURPOSE

With its curving tusks, its ugly, shovel-shaped snout, and its wrinkled, hairless gray skin, the babiroussa is far from being an appealing creature. The tusks, which may grow to seventeen inches in length, project straight up from the jaw, pierce the skin, and curve backward, often reaching the forehead. They are apparently of no use to their owner.

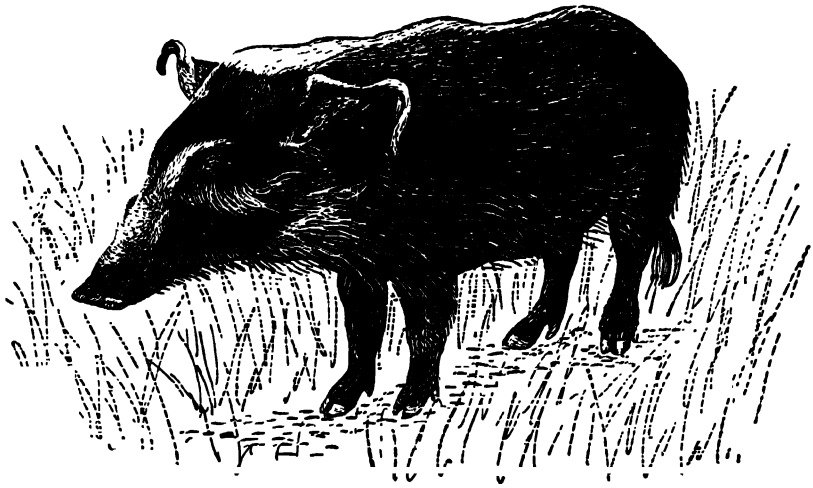
Pygmy Hogs and Bearded Pigs. The Pygmy Hog, *Sus salvanius,* dwells in the forests of the Himalayas in Nepal, Sikkim, and Bhutan. The smallest of all the pigs, it weighs between ten and seventeen pounds. Small herds of about a dozen individuals frequent the tall grass of the jungles. The Bearded Pig of Borneo and Sumatra is a peculiar-looking blackish swine with short, rounded ears, extensive, curly white whiskers, and a wartlike growth covered with bristles between nose and eyes. A tall, lanky pig, it is very high at the shoulders. There are other pigs on the islands of the South Pacific.

AFRICAN WILD PIGS

The African Bush Pig or Red River Hog, *Potamochoerus porcus,* is a wary creature but fierce and tough as well. Seldom seen (it is

active at night), it frequents the dense bush and heavily forested regions.

To the Boers of South Africa, this animal is known as the Boschvark (literally, "bush pig"). The bush pig's coat varies in hue from reddish brown to dark gray or black. Long, tufted ears border the face, which is marked by two pairs of gristly warts growing over bony bases—a large pair in front of the sunken, typically piggish eyes, and a smaller pair behind.



CREATURE OF THE BUSH

The red river hog, one of the South African bush pigs, is the only wild pig at home on Madagascar. Bush pigs are found in many parts of Africa south of the Sahara; they favor reeded areas or low bush country. Many have a large white stripe along the middle of the back. These big porkers avoid man, but will fight to the death if cornered.

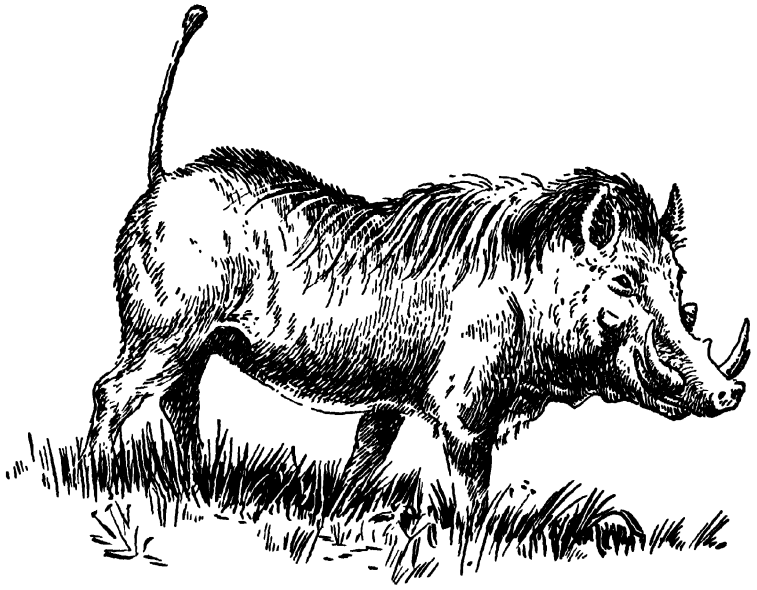
The African bush pig dwells south of the Sahara Desert. It averages a little over two feet at the shoulder and weighs about two hundred pounds. It has a relative on Madagascar—the only member of the even-toed hoofed mammal group that is native to the island.

The Giant Forest Hog, *Hylochoerus meinertzhageni,* was discovered only as recently as 1904. Living in the deep forests, this secretive animal rarely comes out in the open, and we have been able to glean very little authentic information about its habits and life history.

We do know, however, that the giant forest hog is a "giant"—it stands thirty inches at the shoulder and weighs up to 265 pounds. It has very long, bristly hair and a broad, greatly expanded disk on the

snout. The animal's range extends from Mt. Kenya west through the basin of the Congo River to the Atlantic coast.

The Wart Hog or Vlakvark, *Phacochoerus aethiopicus,* has the distinction, if you want to call it that, of usually being considered the ugliest creature on earth. Its head looks enormous in relation to its small, round, fat body, its short legs, and its small feet. With two pairs of warts on the sides of the flat scooplike face, and bleary little piggish eyes sunk in bags of wrinkled skin, the head is fantastically repulsive.



A PERFECT SCORE FOR UGLINESS

No other pig can lay claim to so many repulsive features as the wart hog of Africa. Its face is covered with warts, bumps, and gristle growths. Its eyes are deeply imbedded in sacs of creased skin. Stumpy legs support its heavy gray body, and its overlarge head tapers down to a long, flat snout. The animal makes its home in a hole abandoned by an aardvark or some other creature. Hunters generally find it easy prey.

Near the end of the broad snout are the tusks, which curl out to the side, then up and over. Ten inches is about average for the tusks, though some may measure up to twenty-seven inches. Aside from the few white whiskers on the face, and the scanty mane of dark, long,

coarse bristles, the animal has little hair. A large boar stands thirty inches at the shoulder and weighs two hundred pounds or more.

Active during all hours of the day, the wart hog favors the open grassy plains of central and northeastern Africa. Though this beast, like other hogs, will dig up the ground for roots and tubers, it is occasionally seen grazing on the plains with herds of zebra and antelope.

WHERE PIGS BELONG IN THE ANIMAL KINGDOM

We have already had a look at some of the pigs, but we have not yet considered what position they occupy in the animal kingdom. Although they have hoofs, these are not the same as the horse's or rhino's. Pigs belong to the large group of even-toed hoofed mammals. As we have seen, the term "even-toed" does not refer to the *number* of toes. These creatures have no first toe at all, and the second and fifth toes are often lacking as well. Where the second and fifth toes are present, they generally serve no major purpose.

So it is the third and fourth toes that matter, and that is why these animals are called "even-toed." On solid ground it is these toes that support the weight of the body. All the members of this order are called the Artiodactyla, a word meaning "even-fingered."

The group is in turn divided into three smaller sections, or suborders. These are:

The Suiformes—the ones that do not chew the cud: the pigs, peccaries, and hippopotamuses.

The Tylopoda ("knobby feet")—primitive ruminants, or cud-chewers, that have tusklike outer incisor teeth as well as canines in the upper jaw. In this group we find the camels, dromedaries, llamas, alpacas, vicuñas, and guanacos.

The Ruminantia—these are the true ruminants, that have no teeth at the front of the upper jaw. In this group are all the animals that have paired horns or antlers supported by bony outgrowths of the skull: all the deer, antelopes, sheep, goats, cattle, and giraffes.

Of course it is not because they have horns or antlers that we call these animals ruminants. That word simply means that the creatures to which we apply it chew the cud. Their stomach, instead of being a simple compartment, is divided into a series of three—sometimes four—chambers. The first one is called the rumen (whence the group name). A ruminant has the advantage over other kinds of animals of

being able to swallow large quantities of food quickly and store it up in the rumen. At leisure, the ruminant brings the food back up into its mouth and chews it thoroughly so it can be digested easily.

It is interesting to observe how a ruminant chews its cud—the undigested food brought up from the stomach. As the animal chews, the lower jaw moves from side to side, but only the teeth at one side of the jaw are in contact at one time. After a brief period, the cud is shifted over to the other cheek and milled on that side for a while.

With these distinctions in mind, we may turn back to the pigs and their interesting relatives and understand them better, now that we understand their place in nature.

PECCARIES—PIGLIKE CREATURES OF THE NEW WORLD

Peccaries are forest animals and travel in bands ranging from a few individuals to as many as three hundred. Like the true pigs, they are rooters, feeding on tubers, roots, fruits, and other vegetable matter. But they also prey on small animal life, including snakes.

A peccary never misses a chance to kill even a large rattlesnake. With its mane and body hair bristling in all directions, the peccary fiercely charges to within three feet of the reptile, stops short, and feints it into striking. As the snake lies uncoiled for an instant, the peccary suddenly leaps into the air, with its back arched and its feet together, it comes slashing down on all four hoofs. Again and again it does this, until it has cut the snake to ribbons. (The domestic pig, it should be noted, is also an efficient destroyer of snakes, including rattlers.)

We sometimes read tales of ferocious bands of peccaries attacking human beings. This makes interesting reading but has little foundation in fact. The truth of the matter seems to be that, in general, the peccary is a shy and retiring creature, fighting only for self-protection.

PECCARIES AND PIGS

Peccaries are the only piglike animals native to America, but they are not true pigs. The most obvious differences that separate the peccaries from the Old World pigs include: the loss of the small outer hoof on the hind foot; straight tusks that point downward, in the upper jaw; a large musk gland on the back, about eight inches above

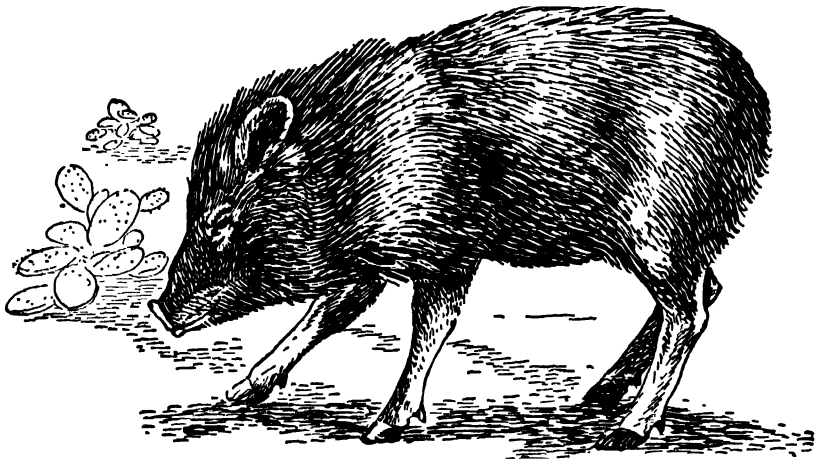
the tail. The peccary's tanned hide, especially durable and popular as glove leather, can be recognized by the pattern of evenly distributed groups of three holes left by hair roots.

Both peccaries and Old World pigs behave in much the same way, though there is a slight difference in breeding habits. The den may be a hollow tree, or a nest in a thicket. At birth the young are about the size of a rabbit, and yellowish brown in color with a black stripe down the back. Two babies are normal for a litter; occasionally there is only one, and in rare cases there are three.

Pigs make up the family Suidae. The peccaries have their own family, Tayassuidae.

There are two kinds of peccaries, divided into smaller groups that differ a bit in size and markings, as well as the regions they live in. We find them all the way from southern Texas and Arizona down to Patagonia.

The Collared Peccary, Javeline, or Musk Hog, *Tagassu tajacu,* dwells in the extreme southern United States and south to Patagonia—sometimes at sea level, sometimes at altitudes of eight thousand feet. A light-



ONE OF AMERICA'S NATIVE "PIGS"

The peccaries, animals of the Western Hemisphere, are not true pigs, though they closely resemble them. They are furious fighters when attacked, and are fully capable of smashing a large rattlesnake to bits. Legend has it that they will attack human beings, but this has never been proved; confronted by man, the peccary would rather retire, and only fights to save its own skin. Above is the collared peccary, a native of southern North America as well as of South America.

colored stripe almost circles the body at the shoulders to form a collar.

This animal is covered with thick, coarse, bristlelike hair, grizzled in color; it does not have much of a tail. About twenty inches high at the shoulder, the collared peccary is three feet long and weighs about fifty pounds.

The White-lipped Peccary, *Tagassu pecari,* is larger than its collared cousin and lacks the shoulder stripes. Its coarse black hair is relieved by a white area that reaches from the chin nearly to the eye. This animal is not quite so far-ranging as the collared variety, living in the region that extends from southern Mexico to Paraguay. In South America the white-lipped peccary prefers low country.

HIPPOPOTAMUSES—RIVER-HORSES OF AFRICA

"Hippopotamus" comes from the Greek and literally means "river-horse." It is a large, ungainly word, very suitable for this large, ungainly creature. The hippo, as we may conveniently call it, has a bulky, rotund body, and legs so short that its ample belly barely misses scraping the ground. Its enormous head rounds out into a bulbous snout.

The hippo's nostrils and eyes are located quite strategically. The nostrils are placed forward and on top of the snout, while the small, bulging eyes are high up on the front of the head. When the animal is swimming, it can breathe and see while only the very top of its flat face is exposed above the water line. The ears, by the way, are small and rounded, set well back on the head behind the eyes.

In prehistoric times the hippo lived in Europe. In those far-off days, it was common in the valley of the Thames and ranged north to Yorkshire as a contemporary of primitive man. Eventually the hippos disappeared everywhere but in Africa, and they are now making their last stand on the Dark Continent.

The family name of the hippos is big, the content small. The Hippopotamidae family contains just the Common Hippo and the Pygmy Hippo.

THE COMMON HIPPOPOTAMUS—INTERESTING, BUT NO BEAUTY

The Common Hippopotamus, *Hippopotamus amphibius,* once frequented most of the large lakes and rivers of Africa, but today we do

not find it south of Zululand. It lives unmolested in crocodile-infested waters, too formidable an adversary for even these powerful reptiles. Its canines can rip through the crocodile's armor plate with one bite.

The hippo does not mind salt or brackish water. Not a fast or particularly adept swimmer, it is built for slow paddling and walking on the bottom in shallow water as it roots up water plants with its tusks. However, it swims powerfully enough to be able to make its way upstream against a strong current.

Though it feeds chiefly on the reeds and grasses that abound in and around watery surroundings, the hippo comes ashore under cover of darkness to raid the truck gardens of the natives. Hippos frequently bask in the sunshine on the lakes and rivers of Africa, each animal pillowing its head on another's back. How restful this may be is not clear, for some say that a full-grown hippo's head weighs a ton!

The hippo has an adjusting mechanism for the time it spends in the dry atmosphere, when it has come ashore to feed; it is equipped with special skin pores that secrete a thick, oily, pinkish substance. This secretion may also act as a protective measure against extended periods in the water. The process of giving off the pinkish fluid from the skin gave rise to the illusion that the hippo "sweats blood."

The hippo can float like a log or sink like ballast and run along the bottom of a lake at eight miles an hour. It generally submerges for about two minutes at a time, but it can stay under water for as long as thirty minutes if necessary. The valvelike nostrils close when the animal dives; as it surfaces, they open with a loud snort and a fine, moist spray is expelled a foot high. When a hippo sports at night, its blowings and snortings can be heard at a considerable distance. During the daytime the animal sleeps on a sandy bank or among thick beds of reeds.

IT MAY WEIGH FOUR TONS

The hippo will never win a bathing beauty contest, yet it is a most interesting animal to look at closely. Its size is most impressive. A hippo will weigh up to four tons, and stand four and one-half feet at the shoulder. Its head and body length may come to twelve feet, and the tail is another foot long. Except for a few bristly hairs on the nose, head, and tail, the animal is naked. Its skin is thick and dark brownish in color.

Next to the whale, the hippo has the largest mouth of any mammal. We get the impression that this beast takes great delight in displaying the awesome gape of its tremendous jaws.

The hippo's incisor and canine teeth are large, with sharp edges that are kept honed as the teeth of the upper and lower jaw grind past each other when the mouth opens and closes. The lower canines may reach four to seven pounds in weight and over twenty-four inches in length. More than half of this huge expanse, though, is hidden beneath the gum line. These sickle-shaped teeth are well suited for cutting the tall reeds, grasses, and water plants on which the hippo feeds. The tusks are commercially valuable as a source of ivory. (However, the ivory they yield is very brittle, and splinters with the expansion and contraction produced by heat and cold.)

By now you may have gathered that the author has something of a special admiration for hippos. As a rule, he finds it hard to forgo an opportunity to photograph them. Some years ago, while he was taking a picture of a bull hippo swimming near the edge of a lagoon in East Africa, one of his companions fired a big elephant gun at the creature. At the time the members of the party were apparently standing on floating masses of vegetation. With the force of the shock of the gun's discharge, the vegetation tipped and the men lost their footing. Meanwhile the hippo sank.

Next morning the body of the animal was seen floating, and natives from far and near had congregated on the bank in anticipation of a feast. However, their fear of crocodiles kept them out of the water. After much argument, they seized one screaming member of their motley crew and hurled him bodily through the air to the farther side of the floating body. Discovering in this way that no snapping jaws of crocodiles were in evidence, they all waded in and dragged the great beast onto the beach. It was not long before all the meat had been stripped from the bones and carried away to the village.

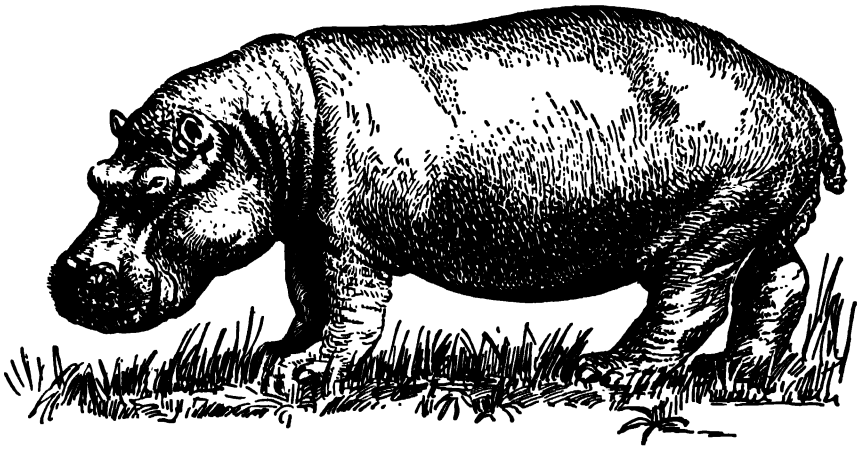
The meat of the hippo is rather stringy and has a machine-oil taste. Yet the natives love it, especially the fat, which they render down as lard. They claim that it never goes rancid.

HIPPOS' TRAVELS AND TASTES

A hippo is more active than is generally supposed. It can run on land as fast as a man and even gallop at a considerable speed. When

running or walking, its legs are so widely separated on either side of its fat body that two parallel lines of tracks are left on the sand or mud.

Old bulls usually live alone, but twenty or thirty individuals may keep together and cover long distances in search of food, often traveling twenty or twenty-five miles by river in one night. Usually, however, they will not venture more than a mile or so, in order to be able to get back to their sleeping quarters before daylight.



BIG COUSIN OF THE PIGS

The hippo's flat, grotesque face is admirably constructed for the life this animal leads in Africa's rivers. The tiny eyes are placed high and close together; the nostrils are well forward, on top of the snout. When the hippo journeys in the water, the top of its face remains above the surface, and so the great beast is able to breathe and see while swimming. This four-ton creature is very much a vegetarian.

The famous wandering hippo Huberta created world-wide interest by traveling some 1,200 miles. Leaving Zululand in November, 1928, Huberta arrived at the Keiskama River in April, 1931; there, unfortunately, the beast was shot. Huberta had an uncanny habit of showing up unexpectedly and then stealing away silently into the bush, or disappearing quietly into the water before anyone could come close.

If hippos wander too far from water, they expose themselves to attack by lions. On one occasion, three of the big cats jumped a hippo and the deafening roar of the conflict could be heard at a camp a

mile away. Dragging its assailants with it, the hippo managed to struggle along until it reached the water and escaped.

Hippos apparently object to campfires. Generally they voice their resentment with loud grunts, but, on occasion, they have been known to go further, climbing onto shore and charging the offending fire, to the consternation of the campers. Aside from such grunts, Mr. Hippo's vocal achievements consist of low, panting breaths followed by trumpeting snorts that end in a roaring bellow of considerable volume.

BABY HIPPOS

Hippos are sociable beasts, gathering in herds of twenty to thirty. When mating time arrives, the bulls turn savage, and fight brutal battles among themselves for possession of the females. Often these duels end fatally as the fighters cut huge three-inch gashes in each other's hide with their sharp tusks.

Hippos mate once a year. Eight or nine months later, the female comes ashore or retreats to a bed of reeds to give birth to her single calf. The baby hippo weighs about one hundred pounds at birth and can swim before it can walk. Suckling usually takes place in the water. During the period of infancy the young rides its mother's back in the water.

A baby hippo must stand up to nurse, whether in shallow water or on land. Park keepers experience great difficulty in getting newborn hippos to suckle. It is not always possible to duplicate natural conditions, where the baby calf can be in the water yet at the same time be able to stand on the bottom and hold its mouth high enough out of the water to reach its mother's udder.

A HIPPO NAMED PETE

A large bull hippo named Pete was born in 1903 and died in 1953 a few months shy of the half-century mark. By the time he was three years old, he weighed 1,700 pounds. When he grew up he weighed about two tons, as estimated by his water displacement. His daily rations were ninety pounds of hay and thirty-six pounds of soup. He spent most of his life in jovial acceptance of his lot at the Bronx Park Zoo in New York, finally dying of old age. A bull hippo at the London Zoo weighed 8,960 pounds—probably a record.

TALL TALE?

Native African tradition tells of a huge, strange animal, known as a chipekwe, that lives in the waters of fifty-mile-long Lake Bangweulu. Described as having a smooth body like a hippopotamus, this creature is supposed to be armed with a horn like a rhinoceros. The horn is said to be of white ivory, smooth and highly polished.

No such animal has come out of Africa, but then, in recent years, many of the so-called mysterious beasts that were known only to the natives have turned up as actually existing in remote parts of Africa. Perhaps Mr. Chipekwe will prove to be real after all.

PYGMY HIPPOS

The Pygmy Hippopotamus, *Choeropsis liberiensis,* frequents small rivers in deep forest country in Liberia and Sierra Leone in West Africa. It spends much of its time on land and sleeps during the day in a den under a river bank. A little under three feet at the shoulder and six feet long, this animal weighs a mere four hundred pounds—truly a pygmy among the hippos.

In general, except for being smaller and less sociable, the life, habits, and appearance of the pygmy hippo are quite similar to those of its huge relative. Even its life span in the wild state—thirty to thirty-five years—is the same; and the female gives birth to her baby after the same interval after mating.

Camels and Llamas—
Beasts of Burden Since Ancient Days

CAMELS, on first acquaintance, appear to be supercilious creatures with smug, disdainful expressions. Worse yet—they may strike us as bad tempered, irritable, and obstinate. Seemingly placid and stupid, they are keen enough to resent actively any form of ill-treatment. With tenacious memory, camels will carry a grudge for a long time, waiting for the opportunity to get even when the offender is off guard. These beasts show their displeasure in a most unsavory manner: they turn the head to spit contemptuously full in the face of the person they resent.

Their relatives the llamas are equally quick to show their annoyance. If they are loaded too heavily, they grumble in their guttural voices and often lie down and refuse to budge. They also spit at the offending driver—with a remarkable degree of accuracy. The charge consists of a disgusting green mess of half-digested grass that is exploded violently through the mouth and nose.

But these qualities are only part—a very minor part—of the story of these animals, and their immense usefulness to man over a period of thousands of years.

The scientists tell us, surprisingly enough, that the camel family had its start, not in Asia as we might suppose, but in North America. That was about forty million years ago. By the end of the Pleistocene epoch, barely a million years ago, the camel family had spread to South America—and to Asia as well, by an intercontinental land bridge that existed in prehistoric times.

What about the camel family today? The camels and llamas make up a fast-waning group that has almost disappeared in the wild state. Only two truly wild varieties are left. Both belong to the llamas, the New World branch of the family. Restricted to South America, the llamas frequent upland plains and, more generally, the highlands of

the Andes. The camels, of course, are creatures of the Asiatic and African deserts.

The camel family (Camelidae) makes up the suborder Tylopoda, as we have seen—one of the groups in the order of even-toed hoofed mammals.

HOW CAMELS ARE ADAPTED FOR LIFE IN THE DESERT

Camels are very hardy and can bear up under extreme privation. These are ideal qualities in a beast of burden that is used in regions ranging from broiling arid deserts to freezing mountain country.

The camel's body is covered with soft, fine, woolly hair, usually dark brown or yellowish brown in color, from which high-quality cloth is made. The flesh and milk are food and drink to some native peoples. The hump of the camel is composed of fatty tissue used by the animal as a reserve of sustenance when the food supply runs low.

As for the stomach, it has three chambers. One of them is lined with water-storing cells that can hold upwards of a gallon. A camel can go three days without drinking and suffer little inconvenience. One camel has been observed to go thirty-four days without drinking; this, however, is far above the usual capacity for doing without water. Given free access to water, a camel will consume from five to seven gallons each day.

Camels are vegetarians and cud-chewers. Unlike the typical ruminants that keep the food on one side of the mouth for some time, the camel constantly works the cud from side to side with each champ of the jaws. The tusklike outer incisor teeth and canines of the upper jaw, excellent for cutting herbage, can also inflict a severe and painful bite.

The creature's ears are small and inconspicuous. Well-haired, slitlike nostrils can be closed against windblown sand, while a double row of heavy lashes protects the eyes from particles of flying grit. Long legs and broad feet are further adaptations for life on the shifting sandy wastes. The foot is made up of two toes provided with thick, cushioned soles and nail-like hoofs. Camels walk with a long, swinging stride. They pace—that is, the front and rear legs on the same side of the body move forward in unison. This produces a rolling effect that may have some connection with the animal's being called the "ship of the desert."

THE MATING OF CAMELS

There are several misleading and even fantastic beliefs about the mating habits of the camel. Strangely enough, some of these notions are given credence in recently published literature and in what would seem reliable sources.

It has been said, for example, that the reason there are no wild camels today is that they require human assistance when they breed. Since this was not sufficiently available in the past, or so the theory goes, only domestic camels can survive.

A careful survey of the facts reveals no backing for such an idea. There is nothing unusual about the mating of the camel, except that the male or stallion puts his head over the back of his mate and forces her to sit down, with her feet folded beneath her. The procedure from here on is the same as in other four-footed beasts of the field. During mating, the herd surrounds the pair, giving them privacy in the open desert wastes.

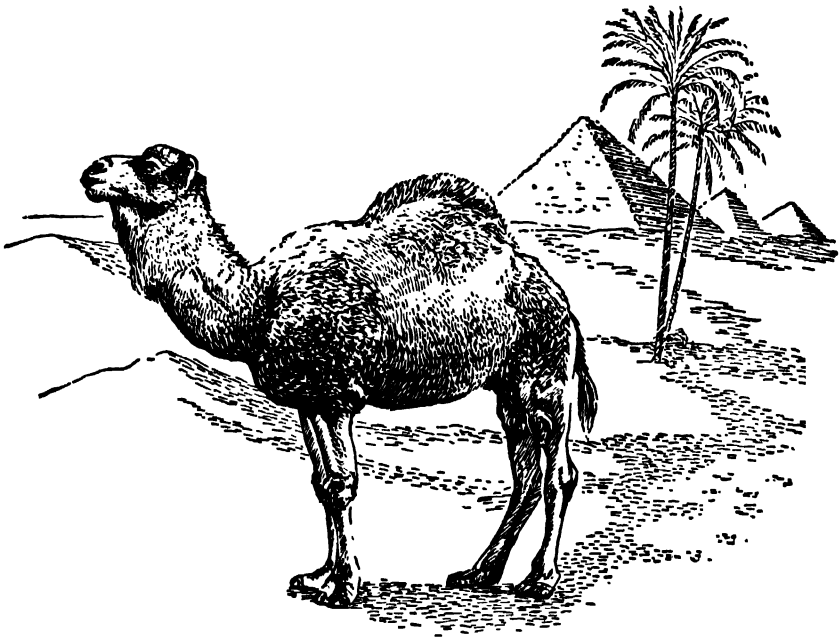
Camels do not have a fixed breeding season; they mate throughout the year. The baby camel is born 315 to 389 days after mating time. Throughout Asia and Africa we find two distinct species, the Bactrian and Dromedary Camels; the regions where they live overlap to a certain extent. From time to time, camels have been introduced with varying success in southern Europe, Australia, and even the United States.

BACTRIAN AND DROMEDARY CAMELS

The Bactrian Camel, or Mecheri, *Camelus bactrianus,* is the two-humped camel common through central Asia from China to Turkestan. The average caravan of these pack animals travels at a rate of two to three miles per hour and thirty miles per day; each camel bears a load of about four hundred pounds.

Though not so slender, handsome, or speedy as the African variety, the Bactrian camel is stronger and more heavily built. Measuring seven feet to the top of the hump, it has stout, moderately long limbs. The body hair is longer and shaggier than on the dromedary; this makes it possible for the Bactrian camel to withstand the rigors of the colder climate prevailing in its range.

The Dromedary, or Heirie, *Camelus dromedarius,* is the one-humped camel of the hot, arid Arabian deserts. Slimmer and sleeker-looking than the Bactrian type, it is a riding camel, with longer legs, better suited for swift travel than for carrying great burdens.



THE DROMEDARY CAMEL AND THE PYRAMIDS ARE OLD FRIENDS

We no longer find the dromedary or one-humped camel of Egypt and Arabia in the wild —this fine desert mount was tamed long ago, and exists today only as a servant of man. Its cousin, the Bactrian or two-humped camel, may still be encountered enjoying its freedom in the Gobi Desert, but doubtless it is the descendant of escaped domestic animals. Camels have a savage temper when aroused, and have been known to kill men.

A dromedary will keep up a pace of eight to ten miles an hour for eighteen hours—one specimen has been known to cover 115 miles in eleven hours over the deserts of Egypt. The soles of the feet are softer and more tender than those of the Bactrian camel—hence the dromedary is less suited to hard and rocky terrain.

CAMEL CARAVANS

To the Arab, the camel is an absolute necessity. It provides him with transportation, of course—and also with milk, meat, and clothing.

True, he prides himself on his horses, but they are for show. No horse could keep up with a camel caravan traveling three or four miles an hour for eight or ten hours a day.

The Arabs drive the camel herds to pasture for a month on waterless plains; at this time the herdsmen survive on the camels' milk. Large camels are expected to carry loads of from four hundred to six hundred pounds, and to travel twenty-five or thirty miles a day.

The author has often seen the Kirghiz women milking camels early in the morning. The animals are so tall that the women stand up to milk them. The milk is then fermented into kumiss, a pleasing beverage which these people drink regularly during the warm summer weather.

Despite the camel's evil reputation, the author personally has great admiration for the animal. A caravan of camels with their robed drivers crossing the burning deserts of Asia is one of the most impressive sights he has ever seen. Camels are stoic, hardy individuals that move steadily along at one uniform pace, never hurrying or lagging from daybreak until far into the dark.

Camels obey orders like good soldiers, though often with grunts of protest when being loaded. Occasionally one will go on a rampage. The author recalls an occasion when one of his camels in central Asia started to buck; its long legs seemed to be flying in all directions while cooking utensils and personal equipment were spread all over the landscape. It was some time before the drivers could stop laughing long enough to catch the beast. One young camel that was being weaned kept up such a constant bleat all night long that it was hard to get a chance to sleep.

The fact remains that when raised and treated with kindness and understanding, a camel is just as cooperative and helpful as a horse.

CAMELS IN ANCIENT TIMES

Camels are descendants of a stock that has been in man's service for at least five thousand years, or since the beginning of recorded history. These animals were known in ancient China. The Babylonians were using camels about 1,000 B.C.

From the Old Testament we learn that Abraham had sheep, oxen, asses, and camels. Job, when he was a rich man, had three thousand camels, and later doubled that number. In Abraham's day, camels

were needed not only for milk, but as beasts of burden when traveling over the wild, pathless land. The life of Abraham must have been much like that of the Bedouin chieftain of today.

Thousands of years after Abraham, the famous phrase about the camel and the needle's eye turns up in the New Testament. In oriental cities there are small gates called "needle's eyes." These are used by late travelers that wish to enter the city after the main gates have been closed. The openings are too low for a camel to pass through in the ordinary way. The beast kneels down and, after having been unloaded, it is able to shuffle through on its knees.

CAMELS IN THE UNITED STATES

Few Americans are aware that these odd-looking creatures came close to being established as accredited domesticated animals in the United States. The attempt began in 1855, when Congress appropriated thirty thousand dollars to introduce camels for use in the frontier garrisons and settlements of the Southwest, where Indians were particularly troublesome.

On February 15, 1856, the ship *Supply* sailed from Smyrna carrying a cargo of thirty-three camels. Other shipments were also made, and a number of private firms followed the government's example. However, the camels did not prove a success and most of them were turned loose. Soon they became a menace to crops and stampeded horses. Nevada passed an act prohibiting camels at large anywhere within its borders. The camels, now running wild, were shot on sight.

The last of the marauders met its death in Yuma, Arizona, in 1899 and was eaten by the Indians. A newspaper commented: "The venerable beast was one of the herd of camels brought from Asia Minor years ago to carry ore from Comstock Mines. So ends the greatest attempt at acclimating foreign animals ever made in the United States."

LLAMAS OF THE PLAINS AND MOUNTAIN SLOPES

Whereas the Old World camel is a creature of the desert, its New World relative the llama dwells on grassy plains and mountain slopes. There are four kinds of llamas; two are domestic, while the other two may still be found in the wild state. These South American cud-chewers are slender and more lightly built than camels; they have

like a hornless goat antelope than a camel in superficial appearance. Its flesh is greatly relished by the Indian tribes in the vicinity of its range.

Up until a few years ago, the camel family was the only branch of the mammals that had been left untouched by the fur trade. (True, the wool of the alpaca, vicuña, and camel has been used from time immemorial for making fine cloth.) Originally a wild animal, the guanaco is now raised extensively on farms for its wool and also for its pelt, which is used by the fur trade for making short fur coats and for trimmings.



SOUTH AMERICAN KINSMAN OF THE CAMEL

A close look at the guanaco, one of the llamas, may not reveal its relationship to the camel, but the animals are kinsmen all the same. The guanaco is a smaller animal, of course, and it is not so sturdily built; it also lacks a hump. Although it does not have the strength of the camel, the guanaco is important as a beast of burden in South America.

The guanaco's soft woolly hair is pale yellowish brown on the body, while the head is ashy gray. The newborn young are killed to obtain skins for the beautiful robes called *capas*. The pelt is sold under the

name *Guanaquito.* Used in its natural color or dyed deep brown, it has a general resemblance to fox fur.

Guanacos mate in August or September, and the baby is born ten or eleven months later. The mother nurses the young for six weeks, weans it for another six, and after that the youngster is on its own. There is only a single young at birth.

The Vicuña, or Vicugna, *Vicugna vicugna,* was prized so highly by the Incas that they prescribed the death penalty for anyone who molested this beast without direct authority from the state. The fabric (known as *cumpi*) made from vicuña hair was reserved for Inca royalty. Human hair has been likened to a piece of wire as compared to a silky strand of vicuña wool. Thus, among the hoofed mammals, the animal has the same position as the chinchilla among the rodents.

A domesticated beast, the vicuña still lives in the wild state as well. Standing less than three feet at the shoulder, it is tawny in color with a white bib on the brisket; unlike most members of the llama group, it does not have an excessively luxuriant coat.

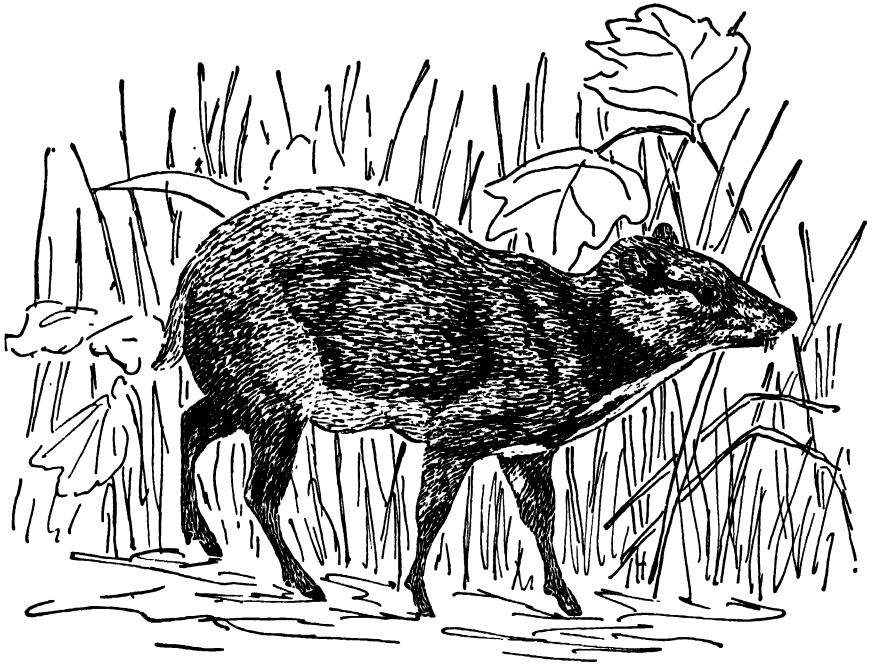
Dwelling at skyscraping altitudes on the slopes of the Andes, the vicuña ranges over Ecuador, Peru, Bolivia, and Chile. This animal travels in small herds of six to twelve females and their young, headed by a lone male. The herd leader, it seems, keeps watch from the highest point in the vicinity of the band. At the approach of danger, he utters a shrill whistle and covers the rear of the retreating herd.

Chevrotains—Mouse Deer of the Jungles

CHEVROTAINS, though they have no horns, look like diminutive, delicately fashioned deer. Silently they tiptoe about with a stilted gait that makes you think their long, slender legs are stiff-kneed and have no joints.

Actually, these creatures of the tropical jungles of Asia and Africa resemble camels and pigs in some respects, deer in others. They are the smallest of all the Asiatic hoofed mammals, approaching the hare in size. The males have tusklike upper canine teeth that project below the mouth like those of certain wild swine.

The chevrotains, or "mouse deer," as they are popularly known, are neither mice nor deer. They are sufficiently distinctive to justify their being placed in a family all by themselves—Tragulidae ("little he-goats").



TINIEST HOOFED MAMMAL IN ASIA

Only the size of a hare, the chevrotain is a delicate animal with long, protruding upper canines that grow down below its mouth. Though zoologically incorrect, its other name, "mouse deer," certainly describes its slender, deerlike body. Quietly, the chevrotain walks about the jungle, its thin legs held so stiffly they seem to have no joints at all.

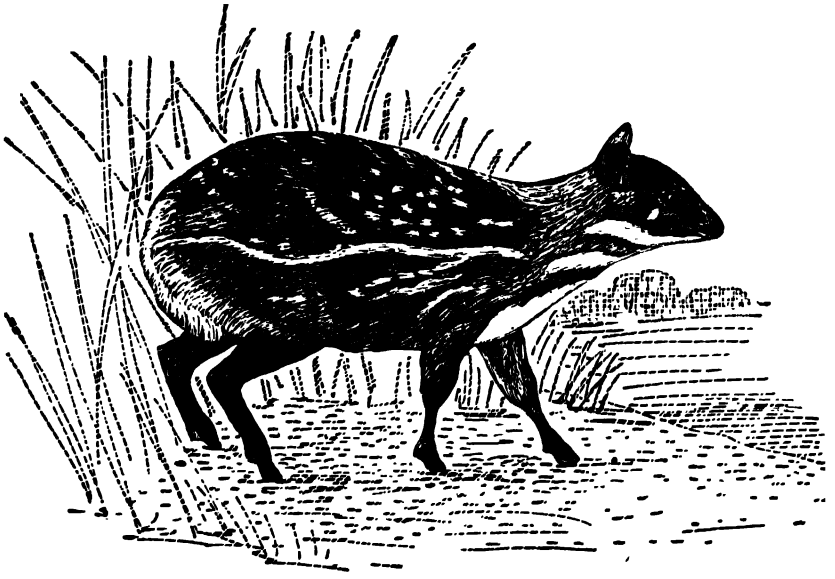
Rather abundant in the regions they frequent, chevrotains are shy and wary, as you would expect of vegetarian animals that lack great strength, impenetrable hides, sharp claws, horns, or other effective means of defense. And their jungle enemies are numerous—snakes, lizards, and flesh-eating mammals.

The little chevrotain is a fair climber, frequently taking refuge in the lower branches of trees when attacked. Some say that when the chevrotain is pursued by hounds, it will jump up in the bushes and hang itself upon a branch by its hooked canine teeth until the danger is over. However, the author is not inclined to take any stock in this notion.

This little creature may make its home four or five thousand feet up in the mountains, but it is most common in low country. It lies up during the heat of the day, preferably in crevices among rocks and other sheltered places; it ventures out to feed only at dusk.

The chevrotain is often found frequenting jungle paths and along roadsides at night. Taken young, it is easily tamed and will not run off into the bush. It has been known to breed in captivity. The only sound it utters is a feeble bleat.

June and July are the months for the rutting season, when the males remain with the females; at all other times both sexes—except



ITS ONLY DEFENSE IS TO HIDE

To fight its many enemies, the timid chevrotain has neither strength, sharp horns, claws, nor any of the other means of protection animals generally have. It can only withdraw into the bush or up trees. The water chevrotain, above, stays in the African marshes, where it rarely ventures out of the tall reeds, so that it is seldom seen by man. An olive brown coat, streaked with white, blends with its surroundings and helps in concealment.

females with young—are solitary. Usually two offspring result from mating.

The Spotted Chevrotain, or Indian Chevrotain, *Tragulus (Moschiola) memina,* dwells in the forests of Ceylon and southern India north to the east-central provinces. This little beast is no more than a foot high at the shoulder, and its head and body length is twenty inches at most; it weighs about five or six pounds, and its tail is a mere stub of less than two inches. Its general body color is light brown, with longish white or buff spots that merge in lengthwise bands along the sides.

There are also two Malayan types that are slightly larger than the Indian chevrotain; they are unspotted, with white under parts, chin, and throat. The African Water Chevrotain, *Hyemoschus,* is somewhat larger than the Asiatic species. It frequents the lakes and water courses of the Cameroons and the Congo. Being a good swimmer, it will take to water on the least provocation.

Deer—Antlered Creatures of the Wildwood

ALTHOUGH THE DEER are mostly animals of the wild, they have always been of the greatest importance to humankind. Their flesh, known as venison, may be a delicacy to us of the West, but to people in far-off places it means life itself. The deer's hide may serve many purposes, and its handsome antlers can be made into useful tools.

We find the deer in all sorts of regions. They are at home in lowland swamps, grassy plains, and sparsely covered brush country; they dwell in dense woodland, too, in mountainous terrain, and even in the snowbound wastes of the Arctic. Just as they live in many different places, so they come in many sizes—they range in bulk all the way

from the dimensions of a spaniel to those of a large horse. In bygone days they were even bigger: the great Irish elk, which we know only from its remains, had antlers that stretched eleven feet from tip to tip.

EATING HABITS—BENEFICIAL OR HARMFUL?

Many deer are forest or woodland animals that feed on grass and tender bark, twigs, and shoots of trees. Thus they aid in keeping the forest floor clear of excessive underbrush. Some observers claim that by pruning the lower branches of young trees, deer aid in producing tall fine timber.

In certain regions of the United States, deer have become overabundant. In such areas, the feeding habits of the animals are a serious menace to the woodlands as well as to farms, which the hungry creatures invade in their search for food. They spill out of the forests in all directions, and have even been known to overrun an airport, interfering with the going and coming of planes. In earlier days, when more flesh-eating animals existed, the numbers of the deer had their natural check. Today it is up to man to restore the balance.

ANTLERS—THE DEER'S CROWNING GLORY

One of the most remarkable features in the entire animal kingdom is the deer's antlers. Generally it is only the male that has them. A few species, the musk deer and the Chinese river deer for example, lack antlers in both sexes; both male and caribou possess them.

The antlers are solid bony growths that develop from permanent bases on the frontal bones of the skull. The deer sheds them annually, usually in midwinter or early spring. About two weeks after the old antlers are dropped, a round furlike ball begins to rise from each base. Very rapidly these small growths swell and expand into the curving and branching structures that will soon grace the head. In this growing stage, the antlers are soft and spongy; their tissues are richly provided with circulating blood.

Growth continues until the supply of blood and nourishment slows down; finally it stops altogether as the blood vessels shrink and cease to function. The antlers now harden to bonelike consistency, while the overlying "velvet" dries up and peels off. The animals burnish and polish the antlers by rubbing them against tree trunks and

branches—a process doubtless prompted by the itching sensation caused by the drying up of living tissues.

This periodic loss and replacement is truly amazing; even the enormous antlers of the moose, which may weigh up to sixty pounds, fall off and reappear every year!

While antlers vary quite a bit in size and shape, those of each species of deer have their typical pattern. Often magnificent as a headdress, the antlers are also formidable as weapons. Although they may be employed against other kinds of animals, more generally the male deer use them in battle for possession of the females.

In their courtship struggles, the males rush at each other with battering, headlong charges. However, the rivals are seldom fatally injured, as the tines, or points, form a basketwork guard that rules out most of the danger from direct piercing thrusts. Occasionally the antlers of two combatants become so firmly interlocked that the animals exhaust themselves in fruitless efforts to escape; in the end they starve to death.

Aside from their remarkable antlers, nearly all the deer are noteworthy for another reason—they lack a gall bladder. Whether this deficiency is fortunate or not, we cannot say; we know nothing about gall-bladder disease among wild animals, though it is a serious ailment in human beings. Still another peculiarity of deer is that they have no central incisors in the upper jaw, their place being taken by a pad of hard gum tissue; this is typical in ruminants. Sharp, dagger-like upper canines are usually present in deer that lack antlers.

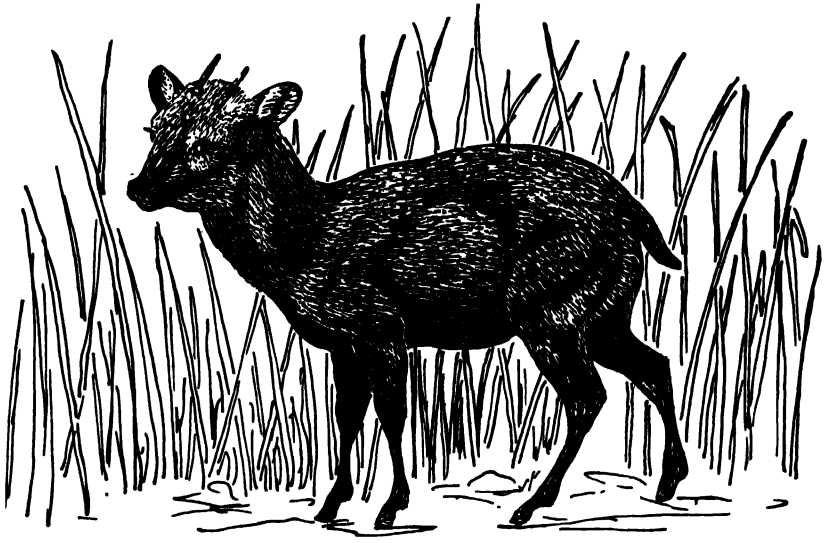
Deer, we have seen, are ruminants. When a deer browses, fresh food is partly masticated, then swallowed, and passed on to the lobe of the stomach known as the "paunch" (rumen). Here it remains to soften and soak. At its leisure, the animal can contract this paunch and return some of the food—now called the cud—to its mouth. This time the cud is thoroughly chewed and swallowed again. Bypassing the paunch, it is digested in other parts of the stomach.

THE DEER FAMILY

There are close to a hundred forms of deer. Probably many more remain to be discovered and identified in the more remote and as yet incompletely explored wildernesses of the world.

The deer family is known as the Cervidae. These even-toed rumi-

nants are spread throughout the Northern Hemisphere, over Asia, Europe, and North America. In the southern half of the globe, their range is limited almost entirely to South America. With the exception of certain kinds of red deer that are found in the Barbary Coast area, this family is absent from Africa, and no native species exists in Madagascar or Australia.



A DEER THE SIZE OF A DOG

Accustomed as we are to thinking of deer as fairly large animals, the Chilean pudu, smallest of American deer, seems surprisingly tiny to us. But the deer family is enormously diversified: it ranges from the massive moose, which is six feet tall and weighs fourteen hundred pounds, to the pudu, which weighs up to twenty-four pounds and stands only thirteen and one-half inches at the shoulder. Its horns are the simplest spikes.

DEER WITHOUT ANTLERS

The Musk Deer, *Moschus moschiferus,* the most primitive of the living deer, is a small creature that favors the wooded slopes at high altitudes in central Asia and at lower elevations in Siberia. We find it throughout the Himalayas as far west as Tibet and north into northern Siberia.

Usually a solitary animal, the musk deer sleeps during the day in a "form" like the hare. In the deep snows of eastern Siberia the author has seen this deer's runways and the forms where it slept. Though he

often found its bed still warm, he never succeeded in glimpsing the animal before it stole silently away. The deer moves about to feed only from evening to early morning. A typical ruminant, it is a vegetarian, browsing on lichens, grasses, and foliage.

——MUSK FOR MATING. The musk which gives this deer its name is developed in an abdominal gland during the rutting season. A single animal produces about one ounce of musk. Many of these deer are killed for the "musk pod," which has considerable commercial value.

The musk is used by the Chinese to make perfume. Only males over three years old are of any value. In North China, where the musk deer is plentiful and the musk pods bring a substantial annual income to the natives, the hunters are careful to kill only the grown males. This much-persecuted little deer often escapes its captors by climbing leaning trees and taking refuge in the thick tops.

The rutting season comes in January, and a single young is born in June; twins are rare. The fawns are ready to mate before they are a year old.

We have already described this animal as primitive. It has a gall bladder, but lacks antlers. Its large ears, short tail, and thick, woolly coat emphasize its resemblance to a large hare. The upper canine teeth in the male are especially long, frequently measuring two or three inches in length. The fur is lengthy, coarse, and brittle.

The musk deer is a pleasing animal to behold. Its coat is a rich dark brown, mottled or spotted with gray in the adult; the young are spotted with white. An average male stands twenty inches at the shoulder and two inches taller at the rump; the hind limbs are longer than the front limbs. The head and body measure about three feet, not counting the tiny stubby tail. The animal weighs twenty to twenty-five pounds.

Worthy of passing mention at this point is the Chinese Water Deer, *Hydropotes inermis*, a dweller in the reed beds and low brush country along the shores and islands of the Yangtze River in China, and in Korea. A small creature without antlers, it is much like the musk deer in appearance. It may give birth to five or six young at a time —whereas one or two fawns are the rule among other deer.

THE MUNTJAK, OR BARKING DEER

The Muntjak, or Barking Deer, *Muntiacus,* is also known as the Jungle Sheep, Red Hog-Deer, and Rib-faced Deer. A small animal, it is rather like the musk deer in size. However, it differs from other deer in a curious feature—the male has tusklike upper canine teeth. Timid and shy, this deer nevertheless makes good use of its long and well-developed canines in fighting off dogs and other natural enemies.

These canine teeth, one notes with interest, are not fixed firmly in the jaw; the muntjak is capable of moving them at will. Some observers believe that the peculiar rattling noise made by several animals together, while on the run, may be produced by the teeth.

Muntjak hunting is a popular sport in southern Asia, and this deer's flesh is considered excellent eating. The muntjak, though a solitary creature, may be attracted in small numbers to one area by the presence of food. However, it keeps close to dense cover and is difficult to shoot.

Wintertime is the favored season for hunting the muntjaks—the natives line one side of a bushy section, and dogs are turned in from the other side and drive the animals toward the hunters. The muntjaks will make a fast getaway, if the hunter is not alert. These deer carry the head and neck low when running, and have a rather ungainly gait.

The muntjak utters a sharp, doglike bark—whence the name "barking deer." The call is often repeated, usually in the early morning or evening and sometimes after dark. The "bark," very loud for an animal the size of the muntjak, is uttered as a mating call or as a cry of alarm.

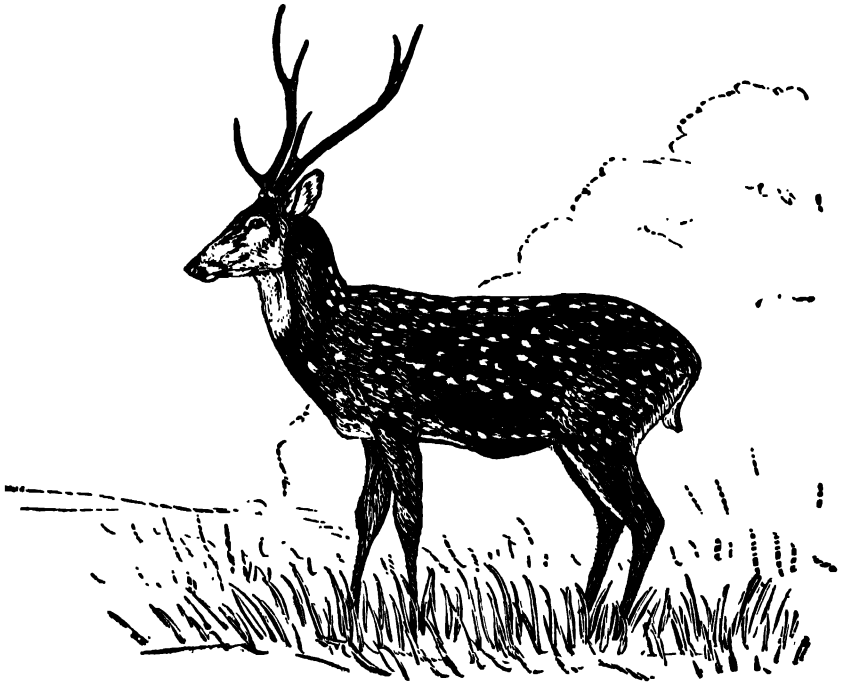
The rutting season in northern India for these deer is in January or February. Six months later, a single fawn is born; sometimes there are twins. The young are spotted at birth and retain their spotted coats until the following year.

The muntjak's two-pronged antlers, five or six inches long, grow from the top of high column-like bases covered with hair. The male drops his horns in May, and the new set is fully grown in August. The muntjak has an exceptionally long, extendible tongue, and can lick the whole of its face with it.

This animal's general color varies from chestnut to tawny or mahogany red. The average shoulder height is two feet at most, with a head

Their mating call is a loud, hoarse, barking sound, easy to recognize but impossible to describe. They also have a shrill cry of alarm.

The axis deer is reddish brown in color and profusely dappled with white spots which it keeps for life. It stands about three feet at the shoulder and weighs two hundred pounds or so. The antlers—they may measure up to three feet in length—are supported on short bases. Usually they have only two tines on each side.



DISTINCTIVE FOR ITS BEAUTIFUL COAT

The axis deer of India has an elegant chestnut coat, heavily dappled with white, which gives it an unusually colorful appearance. Like all ruminants, deer have a unique "delayed action" method of digesting food. The food is swallowed, next stored and softened in a special section of the stomach. Later, at the animal's convenience, it is brought up into the mouth as a cud, chewed, and reswallowed—this time to be completely digested. Oxen, sheep, goats, antelopes, and giraffes also dine this way.

The Hog Deer is a somewhat smaller animal. In India and Burma it is reddish brown, spotted with white in the young. The Eastern Hog Deer of Thailand, Cambodia, Annam, and Cochin China has an unspotted reddish-brown coat. Hog deer are comparatively unso-

cial and travel in groups of no more than two or three. At most the hog deer is twenty-nine inches at the shoulder; the buck has long, slender, three-pointed antlers.

SAMBAR DEER—DEER THAT WALLOW

The Sambar Deer, or Rusine Deer, *Cervus (Rusa) unicolor,* the common deer of southeastern Asia and also the largest, is a forest or woodland creature. It may come out on grassy slopes or open forest glades to feed, but it quickly takes refuge among the trees when danger threatens.

Sambar deer never associate in large herds. Two or three and sometimes half a dozen animals are seen together; stags as well as hinds are often found singly. Hunted on horseback, they maintain a steady but not swift pace, and can easily be overtaken by a good horse in open country.

Grass is the sambar's favorite food, but it also browses on shoots and leaves of trees and often travels long distances to drinking places. It does most of its feeding in the early morning and evening. During the day it lies up in the forest, where it chooses a spot well shaded from the sun's rays.

SAMBARS DREAD INSECTS

The sambar is one of the few members of the deer family that make a habit of wallowing in mud holes like buffaloes and pigs. The animal probably developed this practice to protect itself against insect pests, especially flies. Living as the sambar does in the low, hot tropical jungles, it suffers greatly from these tormentors, particularly after the rains. It is curious that the wallowing habit seems to be limited to the stag; rarely is the hind found in a wallow.

THE MATING CALL

The sambar stag's mating call is a loud, somewhat metallic-sounding bellow. The hind's note is fainter and sharper. October and November are the months of the rutting season. A powerful stag usually appropriates two or three hinds, guarding them jealously from other stags until the mating season is over. Soon afterward, he drops his antlers (they are three-pointed like those of the hog deer).

Eight months after mating time, the hind retires to some secluded thicket in the forest and gives birth to a fawn. For her to have more than one young at a time is a rare occurrence. The young are without spots. In adults the hair is coarse and uniformly dark smoky brown in color.



COMMONEST AND LARGEST DEER OF SOUTHERN ASIA

Like buffalo and pigs, but utterly unlike most other deer, the sambar or rusine deer wallows in mudholes, probably to give itself a protective coating against the insect pests so abundant in the jungle where it lives. This typical Asian deer has a somber-colored coat of coarse brown hair, and massive horns that are long and forked.

We find a number of varieties of the sambar living in different places at elevations of from four thousand to fourteen thousand feet in southern Asia. They vary in size, the largest being the Indian Sambar, which is also found in Ceylon. It stands over five feet at the shoulders and weighs six hundred pounds; its horns measure forty-eight inches in length.

SIKAS—DEER WITH PRECIOUS ANTLERS

The Sika, or Spotted Deer of East Asia, *Cervus (sika) nippon,* is a relatively small deer, lightly spotted, and marked with a light rump patch. We find this handsome animal in Manchuria and along the eastern coast of Asia, as well as on the offshore islands from Formosa to Japan. Subspecies are numerous.

ANTLERS FOR MEDICINE

The sika's antlers, which usually have four tines, are in great demand in the growing stage. The Chinese, who consider them more valuable for medicine than those of other deer, gladly pay high prices for them. In fact, the antlers bring a price of eighty Mexican dollars an ounce. Constant hunting has made the sika deer exceedingly shy.

THE ELUSIVE SIKA

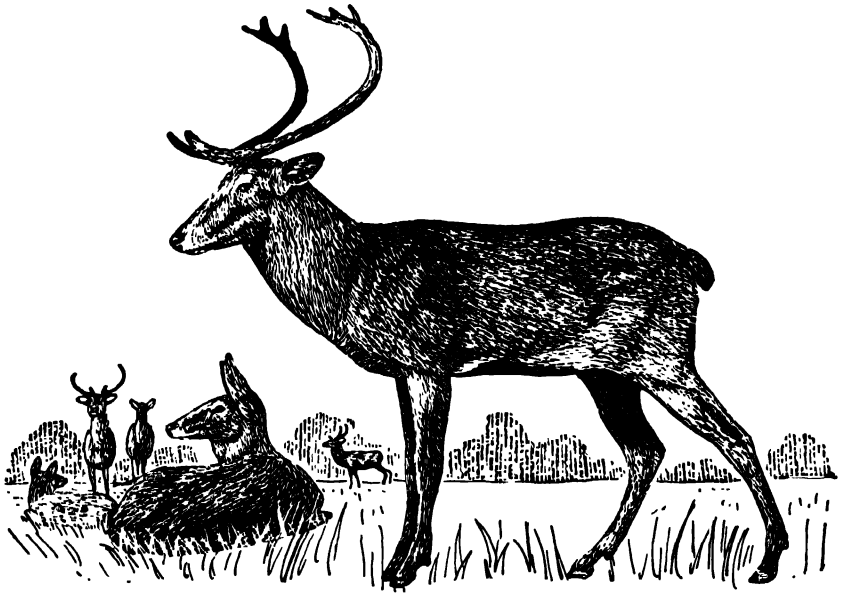
Up until a hundred years ago, some sika species were almost unknown to the West. Père David, an indefatigable naturalist of the last century, heard of a new kind of sika in China and undertook to obtain a specimen. At length his efforts were successful; but a mandarin who disliked foreigners had him arrested and confiscated the animal. In 1867, David's hunters secured a second sika, which was seized by Chinese officials and cut to pieces. However, the resourceful David salvaged the pieces and sent them to France. Scientists call this species *Cervus mandarinus* to commemorate the destructiveness of the Chinese officials.

The sika deer stands about three feet high at the shoulder and has a head and body length of about four feet, plus an eight-inch tail. Its chestnut summer coat is beautifully spotted with white; in winter, the color changes to dull brown and the spots fade and almost disappear.

Schomburgk's Deer is native to the plains of Thailand and may occur in Yunnan, China. The antlers divide into nine or ten prongs, with the long, forked brow tine extending at right angles forward from the main beam. The body color of this large deer is uniformly brown on the back and white beneath.

THAMIN AND SWAMP DEER

The Thamin, or Eld's Deer, *Cervus (Rucervus) eldi,* is a herd deer inhabiting grassy plains and swamps in groups of as many as fifty. They frequent the outskirts of the forest during the heat of the day; at other times they generally keep to more open country.



OFTEN BLINDED IN FIGHTING

Pugnacious in nature, the thamin or brow-antlered deer frequently pays for its fights by losing one or both eyes. Through its sense of hearing, a blinded stag can follow a herd and survive safely; once it is separated from the herd, however, it does not last long.

Known also as the Panolia Deer and the Brow-antlered Deer, the thamin reaches forty-five inches at the shoulder and weighs about 240 pounds. The large antlers have long brow tines, with from two or three to ten points branching from the main beam. The adult wears a brown coat with no contrasting markings. The spotted young—there usually is but one—is born in the late fall and reaches its prime when six or seven years old. The typical thamin is found in Burma and the Malay Peninsula.

The Indian Swamp Deer, or Barasingha, *Cervus (Rucervus) duvaucelli,* despite the first of its names, is not a denizen of marshlands.

Instead, it favors open forests and grassy plains in northern India, where it gathers in large herds during the breeding season.

This animal is a proud-looking, massive creature. It stands four feet at the shoulder and weighs up to 560 pounds. Its handsome antlers, sometimes more than three feet long, bear from ten to sixteen points. In summer it sports a light reddish coat, more or less spotted with white; in wintertime the color changes to yellowish brown.

RED DEER—FAMOUS FOR THEIR GOOD LOOKS

The Red Deer, *Cervus elaphus*, though it lacks the handsomely spotted coat of the axis deer, is considered by naturalists to be among the finest of the deer family. A larger animal, it is sleek, clean-cut, and well proportioned in build. Alert and lordly in bearing, it moves with striking grace. Its appearance is enhanced by an imposing crown of branched antlers. In short, this creature is in many ways the beau ideal among deer.

We find the red deer in many parts of the Old World: in Europe, Asia, and Africa. Its coat is reddish brown in summer, taking on a grayish tinge in winter. A large pale-buff patch marks the rump and extends along the sides of the tail. The full-grown stag stands about four feet at the shoulder and weighs three hundred pounds or more.

ANTLER LORE

In its prime, the stag normally carries six tines on each beam of the antlers—some, in fact, have been found with a far greater number of points. About one in every hundred stags never develops horns; we call such an individual a "hummel" or a "notts." Stags with only a brow tine and one terminal point are known as "switch-horns." Adult stags lose their antlers by March, but a new growth starts almost at once. By autumn, the replacements are fully formed and ready for use in combat.

As we have seen, an average red deer stag in his prime will carry six tines on each beam. The lowest tine over a deer's forehead is called the "brow" tine; the second tine is the "bez," the third the "trez," and the three remaining tines at the top forming a cup are the "sur-royals." A stag with six tines on each antler is a "Royal

Hart," with a total of fourteen points or more it is a "Wilson" or "Imperial."

There is a whole lore and terminology for the deer in England. A barren female is known as a "yeld hind." A two-year-old male is called a "knobber," a three-year male is a "brocket," a four-year male a "staggart," and a fullgrown male a "stag."

THE MATING SEASON

The red deer is a herd animal, but the males and females live apart except during the brief rutting season. The hinds and their offspring form closely knit groups—here we see the workings of the maternal instinct—and are not given to wandering like the males.

Shortly before the breeding season, which opens about September, the stags gather in large, rather loosely organized bands. Playfully they cavort about as they engage in seemingly good-natured fun and mock battles.

Sometimes the whole band will romp as a unit. But once rutting begins, the swollen-necked stags struggle savagely for possession of as many hinds as they can gather. It is only during the mating season, and after, that the males utter their defiant roars of jealousy and anger.

Usually stags do not range over more than a mile or so of their domain, but during the search for females they run at a pace of six miles an hour and cover ten to twenty miles in a day. Once rutting is over, the bands settle down to another year of peaceful association.

FEMALE LEADERS

You may often see the stag pictured as "monarch of the glen." But this is far from the truth—he is not even the leader of the herd. A mature female, old in years but young enough to have her annual calf, is at the head of the band. Her followers are usually her own offspring and the descendants of her calves. When the lead hind stops breeding regularly, she soon loses her authority over the herd.

The hind has a sharp staccato bark, which is a danger signal sounded only by the herd leader. Upon hearing it, the band immediately halts all activity, standing silent and alert. This watchfulness lasts until the matriarch resumes normal behavior by way of signifying that the

danger is past. The moment she moves, the entire assemblage quietly follows.

Once a year, it is true, a stag rounds up each herd of hinds during the rut. But this herd male is merely a temporary policeman who drives away any presumptuous and overly ambitious rivals for his harem.

FROLICSOME YOUNGSTERS

Among red deer, the hind gives birth to her young about eight months after mating. The white-spotted offspring, usually a single fawn—rarely twins—is born in the spring.

Although the baby is able to stand and move immediately after



HANDSOME PRINCE OF THE DEER FAMILY

The red deer, common in temperate Asia and Europe, and especially associated with the Scottish Highlands, stands out as one of the most graceful and elegantly proportioned of all deer. Except at mating time, the sexes live apart. The stags wander off, unmindful of family ties; the affectionate and deeply maternal hinds form small bands, consisting of one matriarch leading her grown offspring and their fawns.

birth, it remains in the bush, where the affectionate mother has concealed it. The hind never wanders very far off from her fawn but returns from time to time to nurse it.

As they become more active, fawns, like the young of many animals, romp and amuse themselves by playing such games as "tag" and "king of the hill." Foot races and make-believe battles, friendly but nonetheless strenuously contested, are favorite pastimes. The young harts and does indulge in an endless variety of springs, bounces, and laughably ridiculous posturings and twistings as they vie with each other in showing off.

MANY KINDS OF RED DEER

The red deer group consists of many species, subspecies, and varieties that differ according to where they live—the British Isles, continental Europe, Asia Minor, Asia proper, and the Mediterranean region of North Africa.

The comely appearance and gentle nature of these beasts make them general favorites among the great parks and forest preserves of the Old World. The Eastern species tend to have a grayer coat than the European types, with large amounts of black on the shoulders, thighs, and under parts. Two varieties worthy of passing mention are the Maral Stag of the Caspian region and the Hangul Stag of the Kashmir valley.

The maral stag (or Persian red deer) is larger than its European cousin, standing four and one-half feet at the shoulder and weighing 560 pounds. As for the hangul, it is often erroneously called the barasingha, a name which properly belongs to the Indian swamp deer. The hangul measures over four feet at the shoulder and weighs 450 pounds. It is a magnificent beast with branching antlers—like those of the European red deer—that may reach a length of fifty inches.

WAPITI—GIANTS OF THE TALL MOUNTAIN TIMBER

The American Wapiti, *Cervus canadensis*, better known in the United States as the Elk ("wapiti" is the name the Shawnee Indians gave it), is the largest of the round-antlered deer. With the exception of the moose, the wapiti is the biggest deer alive in the world today. A full-grown wapiti stands five feet four inches at the shoulder and weighs

from seven hundred to one thousand pounds. The antlers of the adult bull may have as much as a five-foot spread.

FIGHTING FOR A HAREM

The wapiti haunts the tall mountain timber. The sound of the clear "bugle call" by the bull at the beginning of the rutting season in the fall is a challenge to battle with any other male in the neighborhood. Starting in a low, stirring key and rising to a high pitch, it drops abruptly into a harsh scream, followed by a few grunts. An aggressive contender usually answers with a loud, defiant bark and the struggle is on.

In combat the bulls, with their necks swollen and their nostrils



THE WAPITI—BIG AMERICAN COUSIN OF THE RED DEER

The second largest deer in the world after the moose is the American wapiti, or elk, as it is known in the United States; it may weigh up to one thousand pounds. During the mating season, bulls are noted for their fierce battles, in which the victor acquires a harem of cows. Soon, however, bachelor stags appear, to taunt the leader into fighting again for his hard-won gains. Elk teeth were formerly in great demand, and for this reason alone the wapiti used to be slain in large numbers.

distended, rush full tilt and crash into each other, their horns rattling like swords. Occasionally a bull gets his neck broken by the force of the terrific impact. More often, however, one or the other realizes his inferiority after two or three battering passes. Accepting defeat, he gallops away.

Though a powerful bull may number fifty or sixty cows in his harem, a dozen females is the usual retinue. The point is that while an especially powerful stag may collect a large harem of cows for himself, he can rarely keep it very long. Several unmated bachelor stags usually manage to outmaneuver him. At first, to be sure, he is too cautious to be enticed into an all-out brawl by covetous stags; but eventually the taunts of one aspiring competitor will draw the head stag into a fast and furious battle. While he is thus engaged, other stags move in from different directions, split up the herd of cows in small groups, and quickly take them off to the hills. The old stag may win his battle, but his harem is gone and he is too exhausted to follow.

Were it not for such stratagems, the polygamous practices of the herd bull would leave a large number of stags unmated. Their natural instincts would have to go unsatisfied because of the ceaseless vigilance and physical superiority of the master of the harem.

WAPITI ENEMIES

The wolf, coyote, cougar, and bear are natural enemies of the elk. As a rule, a bull elk in possession of his formidable antlers is usually safe from attack by these predatory creatures.

In one combat, according to an eyewitness report, a bear, caught by the savage charge of a maddened wapiti, was pierced through and through by the sharp, many-pronged antlers. Finally nothing remained of the bear but a butchered, gory hulk. The victor's rage was still not appeased. Before turning away into the forest, the elk reduced the body of his victim to an unrecognizable pulp by furiously stamping upon it with his forefeet.

THE LIFE OF A YOUNG WAPITI

The young elk arrives in May or June; it is usually born in open grassland. Within an hour, at most, after birth, the calf (generally

there is only one) is not only able to stand—it can even walk on its wobbly legs! At first its coat is light tawny-brown with large white spots, an effectively inconspicuous pattern among the patches of brilliant light and deep shadow of the woodlands.

A few days after birth, the calf is strong enough to follow the main herd toward the summer range. The mother nurses her baby for the first six weeks, but after that it learns to browse on leaves and twigs. By August, the spots have faded, and late fall finds the calves completely weaned. The animals average a life span of fifteen or sixteen years—in exceptional instances, twenty-two years.

Throughout the summer, herds of elk live high up in the mountains, where they are free from attack by mosquitoes and other insect pests. When fall comes, they descend to lower altitudes, spending the winter in the sheltered valleys and meadows.

Originally the wapiti ranged over most of the United States and southern Canada. Today we find it only in the Rocky Mountain region and the Far West. The closely related wapiti of central and eastern Asia are now included with the red deer groups.

As for the American wapiti, its general body color is pale fawn, but the head and the maned neck are dark chestnut-brown. The large rump patch and short tail are straw-colored. The tremendous antlers have more than five well-developed tines in the adult.

PÈRE DAVID'S DEER AND THÈIR STRANGE ANTLERS

Père David's Deer, or Milu, *Elaphurus davidianus,* is a strange animal to the Chinese way of thinking. They call it *Ssu-ou-hsiang,* "the four unlikes." As they put it, this deer has the tail of an ass, the hoofs of a cow, the neck of a camel, and the antlers of a stag!

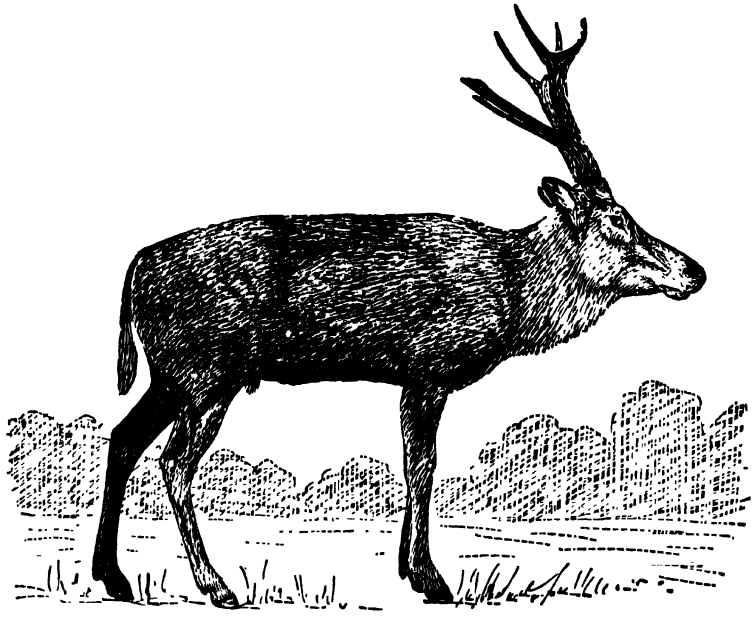
MYSTERIOUS ANTLERS

The antlers of Père David's deer are peculiar in that the front branch comes off fairly high above the base and is usually forked once and sometimes twice. The hind prong is long, slender, and straight, often with small branches at the extremity.

But what is much more remarkable about these antlers is that we have some evidence to indicate that fully adult Père David's deer may actually grow two sets of antlers within a single year—a summer set

and a winter set. Up until they reach maturity, the stags have only one set. When they have two, the antlers are smaller.

Mature stags shed their summer antlers immediately after the rut, at the beginning of November but sometimes as early as September. The shedding of the winter antlers varies a great deal among individuals. Still, no matter how late the animal drops its winter antlers, the new set, even if only partly grown, will harden in time for the mating season in the fall.



EXTINCT IN THE WILD

Known in captivity only, the rare and unusual Père David's deer of China cannot be found anywhere but in private parks and in zoos—a French naturalist discovered it in the gardens of the summer palace at Peiping, where it had apparently long outlived its ancestors in the wild. This animal's antlers are an oddity of the deer world; instead of the customary single set, the adult stag often grows two sets each year—one in the summer and one in winter. Père David's deer likes water—it wades and swims, given the opportunity.

This peculiar trait may be a hangover from past generations when these deer possibly bred twice a year—a new development in the deer family or merely a sport of nature. It is noteworthy that older stags, with their small antlers, cannot compete with the younger animals, whose single set is larger.

APPROACHING EXTINCTION

The reason for this peculiarity will never be solved, as Père David's deer is on the verge of extinction. The few animals now in captivity, however, seem to be increasing the tendency to have two sets of antlers each year. These deer were brought to the attention of the West by the French naturalist Père David, already referred to, who saw a herd of them in the gardens of the Summer Palace at Peiping. They had been royal property for a very long time; no one seemed to know exactly where they came from.

Today this extremely rare deer is being bred only in a few private parks and zoological gardens. Naturalists believe that the animal originally dwelled in the swampy, reed-covered plains that once existed over the greater part of northeastern China. However, they have never succeeded in discovering it in the wild.

Père David's deer is large—three feet, nine inches at the shoulder—with a bushy tail longer than that of other deer. Its moderately small ears are well haired on the inside. The winter coat is full grayish buff, and the young are spotted with white as are most deer fawns.

WHITE-TAILED DEER—THEY CARRY A "SIGNAL FLAG"

The White-tailed Deer, or Virginia Deer, *Odocoileus virginianus,* is a creature of the American woodlands. However, instead of frequenting deep, unbroken forest, it chooses to live where dense woods and thickets alternate with open meadow and sunny forest glades. A shy, secretive animal, it never gathers in groups of more than two or three.

At the approach of danger, the white-tailed deer will silently steal away, with head lowered and "white flag" (the tail) held down tight. The moment the deer starts to run, it throws caution to the winds and carries its tail aloft, waving from side to side—an unmistakable sign of warning for its fellows.

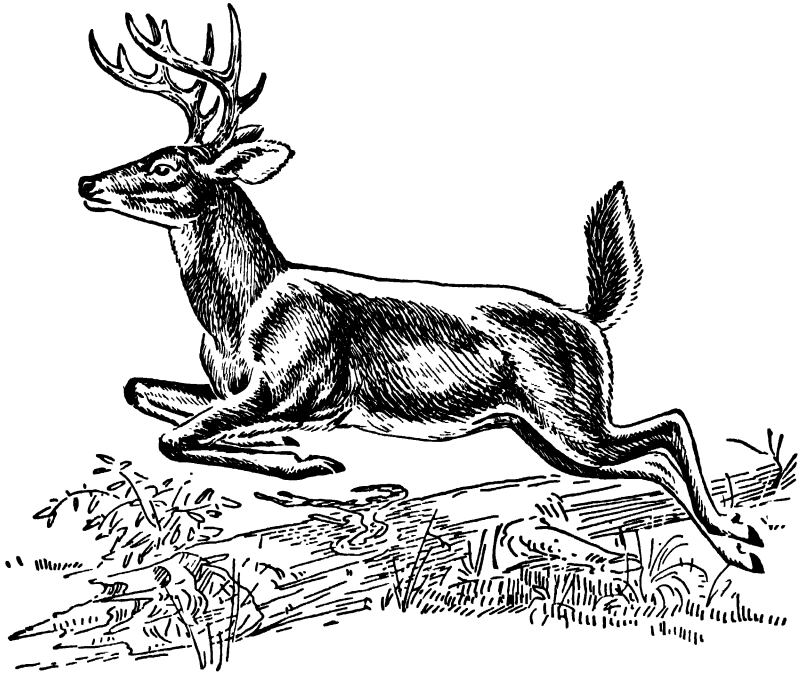
The white-tailed deer is not much of a migrator, and it prefers its own company to that of a herd. About three hundred acres is the extent of this more or less solitary animal's home territory.

DEER VS. RATTLESNAKE

The deer and the rattlesnake are confirmed enemies. Many a mortal combat has taken place between the buzzing reptile and the antlered monarch.

A battle between a snake and a deer is a dramatic spectacle. With head lowered and held sideways for better vision, the buck warily approaches its foe and receives the lunging strike of the snake on its horns. In a flash, the deer springs into the air and lands with all four sharp hoofed feet on the rattler, instantly bounding off to repeat the maneuver. After a few such onslaughts, the snake is literally cut to ribbons.

Though she lacks antlers, the doe attacks in much the same fashion as the buck.



IT RUNS WITH TAIL ALOFT

Seen above in typical motion is the white-tailed or Virginia deer. Small and fleet-footed, it follows an unbeaten trail through thickets and woodland, leaping high over fallen logs, waving its long white-bottomed tail. Once the deer is in its stride, it carries the tail straight. The animal is an unwelcome sight in any orchard—it strips the trees of fruit, twigs, and leaves.

WHITE-TAIL COURTING AND FAMILY LIFE

The bucks start courting the does in October, and the mating season lasts until December. There are fierce fights between the bucks for possession of the does. Frequently their antlers become inseparably locked together and both animals starve to death.

The spotted fawns are usually born in May and weigh about four pounds apiece. The number of young to each doe varies according to the mother's age. Her first-born is single; the second year she may have twins and sometimes triplets. Occasionally there are four—though this is rare for any deer.

The white-tailed deer has a life expectancy of fifteen to twenty years, and a doe may have as many as thirty-one fawns during the first fourteen years of her life.

THE FAR-RANGING WHITE-TAIL

Though most abundant in the northeastern United States, the white-tailed deer ranges over the whole width of North America from southern Canada through Mexico, and down into South America as far as Peru and Bolivia.

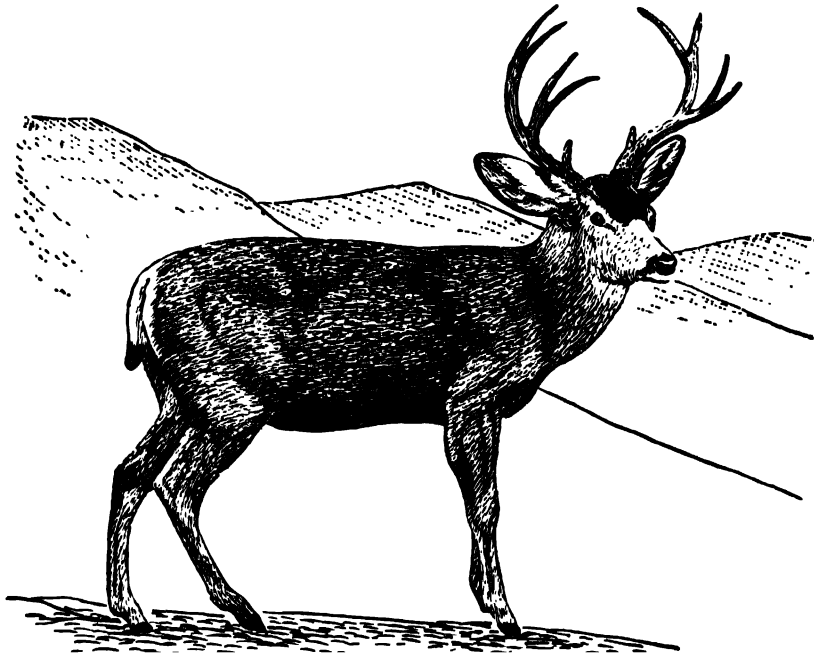
This deer is rather small and graceful. It is also known as the "fan-tailed deer," and its long, bushy tail is conspicuously white on the underside. The back, sides, and limbs of the summer coat are uniformly tawny in color, while the heavier winter dress is more somber and grayish in tone. In both coats the undersides and throat are white.

We find a great deal of difference among the more than a dozen kinds of white-tailed deer, not to mention the numerous local varieties. The more northern of these are among the largest and may reach sixty-six inches in head and body length, with a shoulder height of forty-six inches. The full-grown buck ranges from two hundred to four hundred pounds in weight.

By way of contrast there is the Dwarf White-tailed Deer, measuring only fifty inches from its nose to the root of its tail and weighing less than fifty pounds. The main beam of the antlers in all the white-tailed deer curves forward and the tip inward, giving off two or more erect, unbranched tines.

MULE DEER—NAMED FOR THEIR BIG EARS

The Mule Deer, *Odocoileus hemionus,* is a sociable creature. It follows regular migration routes, spending the warm summer months in the mountains and moving to the sheltered valleys and lower levels in the fall. During such seasonal movements, the combined herds on the trails may number several hundred animals.



A FRIENDLY BUT MUCH-HUNTED FELLOW

The mule deer, named after that other possessor of large ears, is well known in the western part of North America. Hunters value it as food; visitors to national parks find it extremely sociable, and enjoy feeding it out of their hands.

Since the mating season is in the late fall, the fawns are born on the way back to the summer range. The does have their babies—usually twins—six or seven months after mating. There is one instance of a marked doe that gave birth to twins for twenty successive years before becoming barren.

The mule deer has large ears—hence its name. Its appearance is

quite different from the white-tailed deer's in this way, and in many others.

The mule deer has a large whitish rump patch, but the tip of the rather short tail is black. The antlers rise vertically from the head and are evenly divided at the first fork; each tine again divides to produce four or more evenly spaced spikes on each antler.

In summer this animal's coat is tawny or yellowish brown in color; in winter, it is much longer and grayer. An adult buck may stand forty-two inches at the shoulder and measure about sixty inches in length, not including the eight-inch tail. Its weight runs from 150 to two hundred pounds.

There are about a dozen kinds of mule deer, each specializing in its own area, which may be rather large. Occasionally these territories overlap to some extent.

The domain of the mule deer is western North America, from northern Mexico to central British Columbia, and from Colorado in the East to California in the West. The extremes in range are represented by the Southern Mule Deer, an animal that roams Baja California, and the Sitka Deer, found on coastal ranges and islands from north of Juneau, Alaska, to central British Columbia. The Columbia Black-tailed Deer, of the Pacific coast, is still another well-known type.

COLUMBIA BLACK-TAILED DEER—CREATURES WITH COURAGE

The black-tail, like other mule deer, does not lack courage and will sell its life dearly, as shown by a mute picture, which met the eyes of a United States Biological Survey man. The skeletons of a large buck black-tail and a full-grown mountain lion were found lying side by side in a hemlock grove in Oregon. There was evidence of a violent struggle. A round hole in the top of the lion's skull had apparently been made by a prong of the deer's antlers—proof that though the deer had lost its fight for freedom, it had mortally wounded the lion in the conflict.

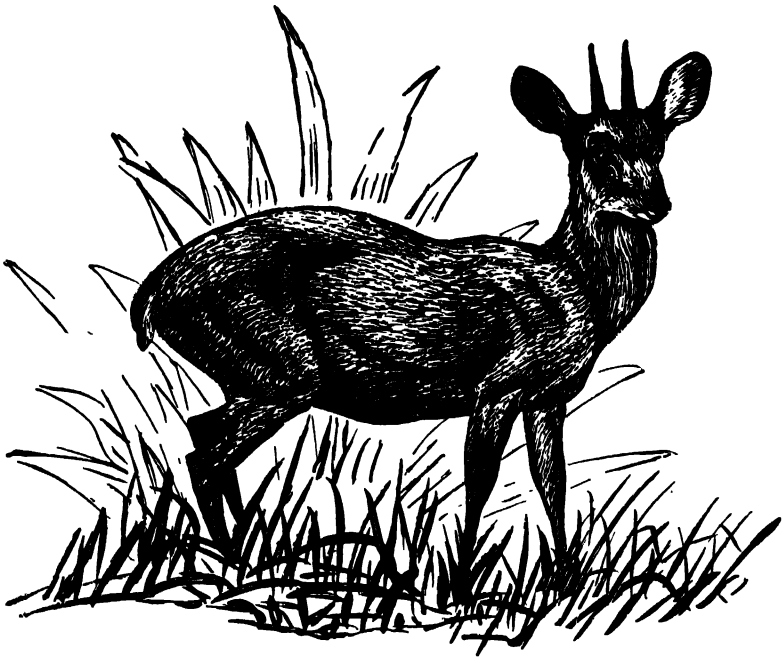
The Columbia black-tailed deer has a longer range than the Sitka deer—it occupies a narrow strip along the Pacific coast from central British Columbia to California. Nowhere does the black-tail range inland beyond the Sierra Nevadas and the Cascade Mountains. It is easy to recognize the Columbia black-tail and the Sitka deer by the

rather long tail, black on the upper surface, and by the forked antlers, which have two main tines of equal size.

These small animals are apparently good swimmers; they have been seen three miles offshore in a heavy sea, headed across Frederick Sound, which is ten miles wide.

CENTRAL AND SOUTH AMERICAN DEER

The Brocket, or Cariacu, *Mazama,* may be encountered all the way from Veracruz, Mexico, through Central America, and into South America. It has short, unbranched spike antlers about half as long as the head. All members of the brocket group are small, stocky deer—the average shoulder height is about two feet. The Pygmy Brocket of central Brazil ranks among the smallest of all true deer, standing



SHORT HORNS ON A SHORT DEER

Though its body is small and squat, and its diminutive antlers are devoid of forks and branches, the brocket or cariacu of South and Central America is nevertheless a true member of the deer family. There is even a pygmy brocket, which stands less than nineteen inches at the shoulder—almost the smallest deer on record.

less than nineteen inches at the shoulder. The body color of these animals is basically brown.

——ALERT, SHY, RETIRING. Brockets are at home in the dense thickets of unbroken forests from sea level to altitudes of sixteen thousand feet. Like other deer, they are browsing animals and feed on leaves, twigs, and green shoots of trees or bushes.

Alert, shy, and retiring, brockets are most active during the early hours of the morning and late evening. Among the hosts of hungry predators ready to devour these timid beasts, big snakes and large cats take the greatest toll.

Brockets are not sociable creatures. They do not gather in herds; instead, a male and female usually join company. The average number of young for an adult doe is two. At birth the fawns are spotted with white. They are able to stand shortly after they come into the world, and in several days they are ready to accompany their parents.

There are at least seven recognized kinds of brockets, with a good many varying types among them. The best known is the Red Brocket of Central America.

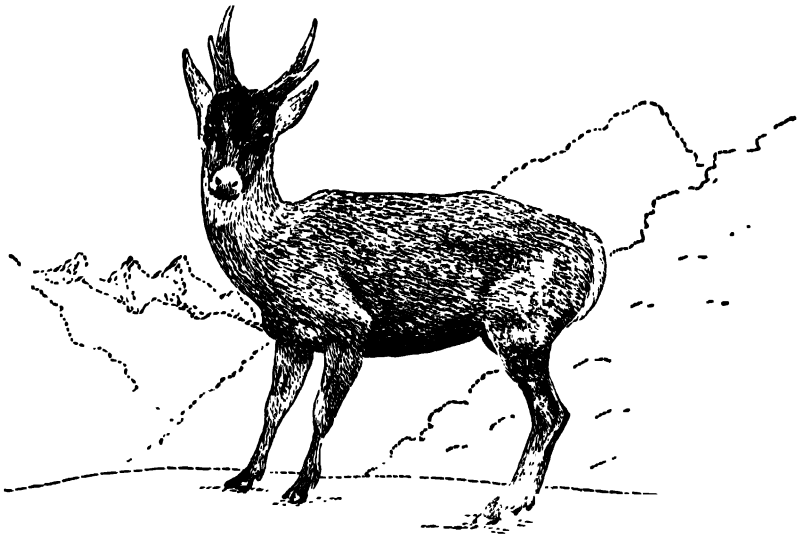
The Andean Deer, Huemul, or Taruga, *Hippocamelus,* is a lover of the heights. The Peruvian Huemul is at home in the Andes at elevations of about three miles in Peru. Its relative the Chilean Huemul remains below the timber line of a range that extends through Chile and western Argentina nearly to the Strait of Magellan. Both have a very odd trait that does them a marked disservice.

——FAR FROM WARY. For some unexplained reason, huemuls appear to be unconcerned about their safety. Observers have testified on more than one occasion to the unusual lack of wariness on the part of these deer.

Thus, one reliable informant states that he walked in full view to within rifle distance of four huemuls, singled out the largest, then fired and missed. A second shot dropped one, but the other three did not run off—they merely stood as if amazed or slowly walked about in a curious, stiff goose-step manner. Meanwhile, a herd of guanacos that was on the same hillside had quickly disappeared over the top of the mountain at the first rifle crack.

Smaller in size than the typical white-tailed deer, the Andean deer has a shoulder height of thirty-nine inches. Its total length, including

the five-inch tail, is sixty-six inches. Males carry heavy antlers, about ten inches long, consisting of one simple fork and two points on each side. The hair is rather coarse and thick in texture and brownish or yellowish brown in color.



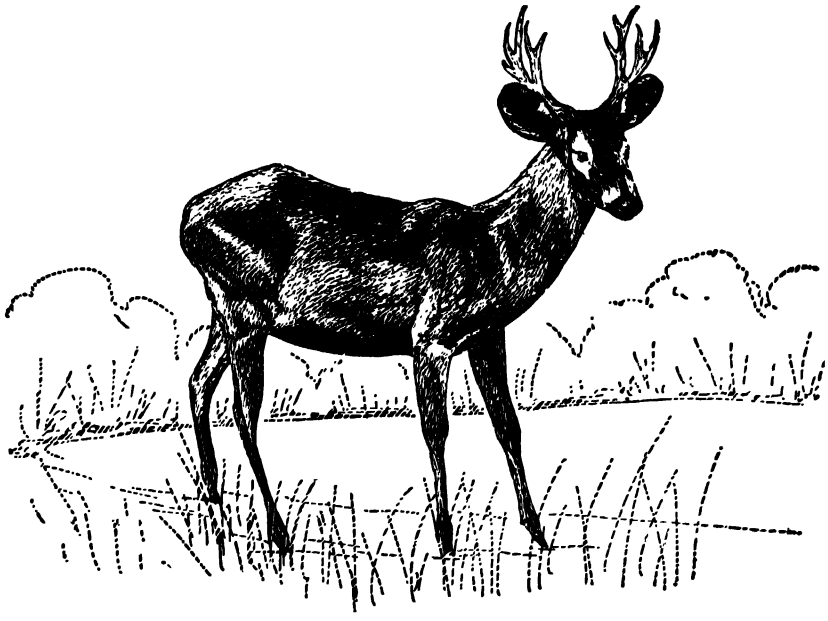
TOO TRUSTING FOR ITS OWN SAFETY

The huemul or guemal lives at altitudes of from fourteen thousand to sixteen thousand feet in the Andes, from Peru to Chile. It is about the size of the Virginia deer and has short, massive antlers with a simple fork. The animal seems to lack the wariness common in most wild creatures, and easily falls victim to hunters.

The Marsh Deer, or Suasupucu, *Blastocerus dichotomus,* is the largest and handsomest deer in South America. A swamp-loving animal that ranges from Brazil to the forested country of Argentina, the marsh deer is about the size of a red deer. Its antlers may exceed twenty inches in length and fork into two equal branches that subdivide, forming ten points in all. The animal's general color is reddish chestnut in summer and browner in winter.

The Pampas Deer, a relative of the marsh deer, lives on the pampas and prairies from Brazil to northern Patagonia. The Chilean Pudu, the smallest American deer, has a shoulder height of about thirteen inches, and weighs twenty-four pounds at most. It takes read-

ily to salt water and crosses over to Chiloe Island off the Chilean coast. The gentle fawns are easily tamed.



BIGGEST OF SOUTH AMERICA'S DEER

The most attractive and the largest member of t[illegible] the marsh deer. This animal makes its home in the forests from Brazil to Argentina, and shows a special fondness for dwelling in and about swamps.

MOOSE—GIANTS OF THE DEER FAMILY

The Moose, *Alces,* known in Europe as the "elk," is the largest living member of the deer family. Towering above the other animals of the northern latitudes, an average full-grown bull stands just under six feet at the shoulder and weighs between a thousand and fourteen hundred pounds. Exceptionally large moose antlers have been known to weigh sixty pounds.

HOMELY, CUMBROUS, AND UNCOUTH

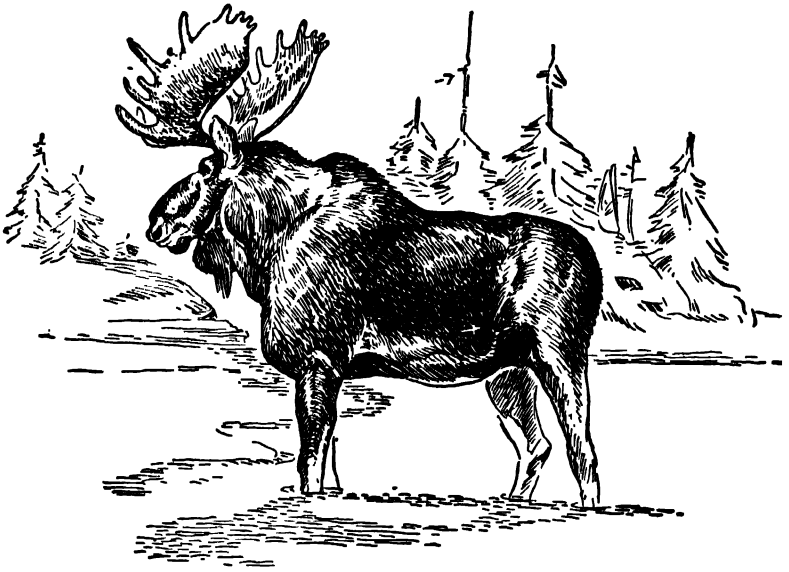
There are some odd shapes and forms in the mammal world, and the moose, homely, cumbrous, and uncouth, has one of them. The shoulders are higher than the rump. The legs seem much too long for the

humpbacked body, and they are certainly too long for the short neck. In fact, a moose cannot reach down after short grass unless it kneels; in order to drink, it must wade into the water.

However, the long legs are useful to the moose in several ways. They enable the animal to reach high up to browse on twigs and leaves of willow trees, and to go into deep water to feed on water lilies—one of its favorite summer foods. At times, when feeding, a moose will wade into water so deep that it will become completely submerged. Finally, the long legs of the moose are well adapted for travel through the tangled masses of down timber (fallen timber) that would prove an impassable barrier to an animal with shorter limbs.

HUGE ANTLERS

Bulls have huge antlers, flattened and bearing numerous points, that may extend sideways from fifty to more than seventy inches. The



THE MONUMENTAL MOOSE

The famous moose is the largest and clumsiest-looking of all deer; its antlers alone may weigh up to sixty pounds. It has a strange, protruding muzzle and an odd mouth with a flexible, overhanging upper lip—well suited for feeding upon foliage. Not nearly so plentiful as it once was, the moose needs protection if it is to survive for long.

tail of the moose is a mere stump; the ears are large. The animal has a long head, with a bulbous nose and an ample, pendulous upper lip. Its coat is long, coarse, and blackish brown in color, with grayish tones on the face, belly, and lower limbs. A growth of skin and long hair, known as the "bell," hangs from the animal's throat.

TERRIFIC BATTLES OF THE MATING SEASON

A solitary animal, the moose generally sticks to one mate. The rutting season occurs in the fall, and the bulls fight terrific battles for possession of the cows. The effects of these mighty duels are visible in the forest for some time—trees are badly scarred, the ground is torn up.

The rut begins in September and lasts until the beginning of October. The calf comes into the world eight months later—in May or thereabouts. The cow moose usually has one baby the first season, but two are not unusual. On rare occasions three are born. Unlike many deer, the moose calf is not spotted or striped with white but resembles the mother in its nearly uniform coloration. How long the moose lives in the wild we cannot say for sure; in captivity it does not survive for longer than a year or two.

WHERE MOOSE EAT

The moose has an extensive domain. Spending the summer in low-lying swamps and lake districts, it turns in wintertime to hardwood mountain ridges. A creature of habit, it roams its domain over well-worn trails to favorite feeding grounds.

In summer, the moose is fond of pond weeds and lily pads. Its principal food in winter is the leaves, shoots, and tender branches of willows, striped maple, and witch hazel.

When the snow lies deep on the ground, the moose keeps short trails open by constant travel. These are known as "moose yards." Occasionally two or three animals will occupy the same clearing in the forest, and gradually extend the size of the yard as food gets scarce.

NEW WORLD AND OLD WORLD MOOSE

There are three or four varieties of North American moose which are distributed from the Rocky Mountain region to Maine and north

through Canada and Alaska. The largest and most powerful of these is the Alaskan Moose, which may attain a shoulder height of eighty-one to ninety-six inches and a maximum weight of eighteen hundred pounds.



THE CLOVEN HOOFPRINTS OF THE DEER

At the left are the delicate footprints of the white-tailed deer, often found near small ponds and lakes. At the right are the longer and more pointed tracks of the moose. Moose tracks are the largest made by any deer.

There are also three kinds of Old World moose. We find the typical European animal in the Scandinavian peninsula and Germany; the typical Siberian and Manchurian forms have an extensive Asiatic range. The antlers of the Old World animals are somewhat flattened; none can even approach the enormous spread of those of the Alaskan moose.

CARIBOU AND REINDEER—"CAMELS OF THE FROZEN NORTH"

Reindeer are far-famed creatures today. Their popularity, however, does not seem to go much further back than a poem which begins with the memorable words " 'Twas the night before Christmas," and introduces the fleet-footed companions of Saint Nicholas—Cupid, Vixen, Comet, and the rest. Ever since Clement Moore wrote his warm-hearted verses in the last century, the reindeer of the far-off North have seemed near and dear to us.

These big beasts are not always so good-humored as is commonly supposed. During the mating season, reindeer are in a fighting mood and extremely dangerous—the air resounds with the crash of their antlers. Many a man has been killed at this season of the year, when the bulls, or stags, battle for supremacy over the harems.

WILD AND DOMESTICATED REINDEER

Reindeer have been called the "Camels of the Frozen North." With the exception of the musk ox, they live farther north than any other hoofed animal; they range beyond the timber line into the Arctic Circle in both the New World and the Old World.

In the wild state, these animals are known as caribou. Today we find caribou chiefly in the New World, where there are Barren Ground Caribou, Woodland Caribou, and Mountain Caribou. There is also an Old World Caribou, known as the reindeer in its domesticated form. (The word "reindeer" appears originally to have meant an "animal that pastures.") Reindeer have been introduced into the New World, and have proved of the greatest value to the Eskimos as a source of food and clothing.

UNIQUE AND PICTURESQUE ANTLERS

The Caribou, *Rangifer,* is the only deer in which we find both sexes with antlers. Even the fawns have small spike antlers which appear two months after birth.

The antlers themselves are unique and picturesque. The main beams sweep gracefully back and upward from the head, spreading as they rise, then bend forward and end in a flattened palm.

The shape and number of tines vary quite a bit. The brow tine usually develops only on one antler and extends down over the face in a broad vertical palm or "shovel." It is generally supposed that the "shovel" is used to dig down through the snow to the underlying moss, on which the animal often feeds. Still, the caribou has more success digging with its feet. The bulls drop their antlers in the early winter; the does carry them until May.

BIG HERDS, LONG MIGRATIONS

The caribou is the most sociable, as well as the most migratory, of all deer. Some of the more northern groups begin to collect in August for the movement south. During the exodus from the open tundra to the shelter of the timber, some may travel several hundred miles. Often the migrating herds number thousands of animals.

When they are traveling, caribou produce a noticeable snapping or clicking sound. This is made by the ankle joints—not, as one might suppose, by the clacking, wide-spreading hoofs. The caribou has a fast-swinging trot that it can keep up almost indefinitely. To this trot it owes its ability to outdistance wolves with ease. An excellent swimmer too, it can only be overtaken in the water by a first-rate canoeman.

A HERD OF 25,000,000

Caribou virtually disappeared from the United States within the memory of some old-timers. The last native caribou in Maine (the wildest part of the northeastern United States), took refuge at Mount Katahdin and was exterminated by 1901. Later, the animals were brought back by man. Caribou fared better in Michigan, where a small herd persists in the northern part of the state. In Mount McKinley National Park the creatures are breeding with reindeer.

Caribou are still abundant in the Canadian Rockies and in the Barren Grounds. Their number, however, was much greater in the past. "Buffalo" Jones, a famous hunter, reported seeing a migrating herd of caribou at Clinton-Colden (in northwestern Canada) that will give you some idea of their former abundance. From where he stood, said Jones, the whole world seemed a moving mass of caribou, extending ten miles each way. They averaged at least one hundred

to an acre and passed at a rate of three miles per hour, traveling day and night. Some herds took four days to pass a particular point.

The naturalist Ernest Thompson Seton estimated the number of caribou in this herd at not less than twenty-five million. He suggested that it was possible there were several herds of similar size in existence at that time.

THE CARIBOU'S ENEMIES

It has been said, and justly so, that, except for sex-maddened bulls, a caribou has never attacked man. This animal is a combination of curiosity and timidity. Once a caribou gets the scent of a man, it will make off at a fast trot. If he is not identified at once, the case is different. With the wind blowing away from it, a caribou will approach a stranger, coming closer and closer until it is ten or twenty yards away, sniffing and snorting. But, the moment it smells danger, off it goes.

On the Arctic tundra, the caribou has few natural foes. On rare occasions it encounters a grizzly, a lynx, or a wolverine. On the other hand, the great white Arctic wolf is a constant menace. In an open chase, the caribou generally outruns the wolf. However, by skulking undetected around the outskirts of a herd, the wolf can maneuver within striking distance of a young or infirm straggler.

Strange as it may seem, the most dreaded enemies of the caribou are the denizens of the insect world. Mosquitoes hover around the warm-blooded animals in dense clouds—the unfortunate caribou must be constantly on the move, headed into the wind. An even greater menace is the botfly or warble fly, which lays its eggs in the caribou's hide. In some regions, young bucks have been found with as many as 120 warble larvae growing on their bodies.

"In midsummer," writes Joseph Dixon, an expert with the United States Fish and Wild Life Service, "caribou often seek high, wind-swept ridges and snow-filled gulches in order to escape the attacks of biting flies and mosquitoes that are abundant in the lowlands. On such trips the bands frequently are led by some old female, probably because she knows where the best green pastures are located and where safety for the weak young caribou may be found.

"Caribou have a keen sense of smell but their eyesight is relatively poor. I have found it possible, by lying flat on the ground, to crawl

slowly down a hill right into the midst of a band of grazing caribou when the wind was blowing from them to me and they could not get my scent. Under such circumstances it was always a female, usually one with a young calf, that first detected my presence."

A WOODLANDS JEST

John McGaw, a hunter, once witnessed a most surprising exhibition of playfulness between a caribou and a fox. While stalking two caribou on Serpentine Hills, near Gander, Newfoundland, he noticed that one of the stags was acting strangely and backing away from some small creature that persisted in jumping up from the ground at its side.

On closer observation, McGaw saw that the curious little creature was a young fox apparently trying to engage the larger animal in a frolic. Repeatedly the fox jumped into the air, snapping its teeth when off the ground. Apparently resenting these maneuvers, the stag lowered its head and charged. The fox skipped nimbly to the other side and repeated its performance.

The game went on for some time, the fox apparently enjoying the sport of teasing its clumsy friend, who did not seem to relish the joke in the slightest degree. Eventually, the merry little fox retreated to safety.

THE CARIBOU AS FOOD

The flesh of the caribou is among the choicest game meats. It is the staple food of the northern Indian and the Eskimo—without the great herds of caribou they would be unable to exist. (Indians of the Tinne tribe are known as "Caribou-eaters"; Eskimos of the Barren Grounds are called "Caribou Eskimos.")

The people of the northland make use of every part of the animal; even the blood, which goes into soup. The flesh consumed, the bones are crushed for their marrow. The shin bone is split to make knives, the horns are fashioned into fishhooks, the tendons converted into thread.

In their utilization of the caribou as food, the Eskimos and Greenlanders appear even to have entered the realm of the scientific dietician. In the summer there is a luxuriant growth of knee-deep grass

in the northern country that the caribou likes to eat; in the winter the animal must rely more on mosses and lichens. "Caribou moss" is decidedly indigestible to man in its natural form. However, chewed and partly digested by a caribou, it becomes a nutritious human food. The people of the Far North eat the contents of the caribou's stomach and call it *nerrooks* or *nerrokak.*

CARIBOU SANITARIUMS

Travelers to the Far North have brought back a delightful story of caribou sanitariums where the animals go to mend their broken limbs. There is every reason to believe this tale! On several occasions, caribou have been found on secluded islands, recovering from broken limbs. They certainly could not have broken a leg on the island but must have swum there from the mainland in order to be safe from attack by wolves and other predatory beasts.

It is interesting to note, in this connection, that nature can mend even the badly broken limbs of her children without any danger of gangrene setting in. Flies lay their eggs in the wound. These hatch into maggots, which devour bacteria-bearing tissue and at the same time deposit a secretion which fights infection.

SOME IMPORTANT CARIBOU

The Barren-ground Caribou, *Rangifer arcticus,* takes its name from the Barren Grounds or Barren Lands of northern Canada, where it dwells. It is very much at home on the tundras of Alaska, too. Indeed, there, the caribou are the commonest of big game. Although fairly well protected, the animals seem to be moving further north in their search for safety.

Usually the antlers of the Barren Ground caribou are very long and slender, and with several points projecting from the flattened tips. Here are some features they have in common with other caribou:

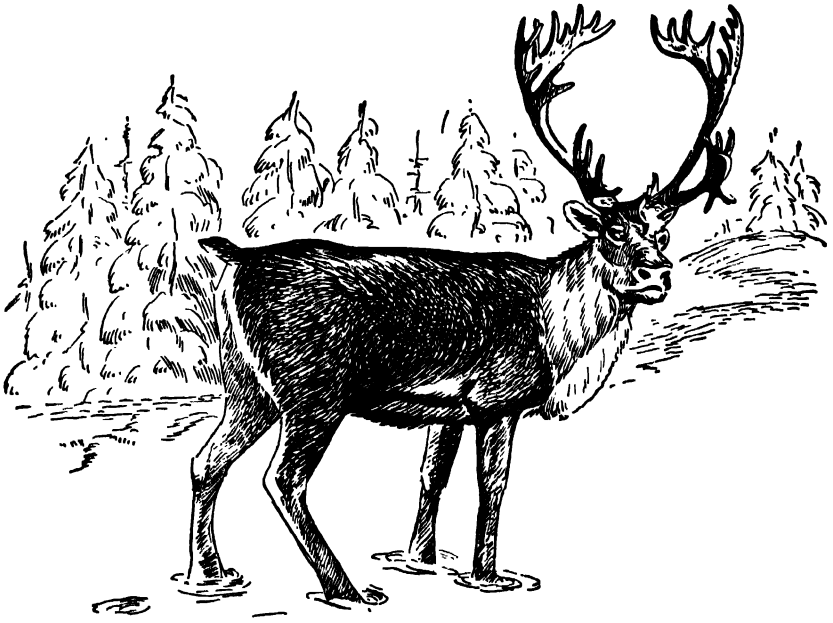
The cloven hoofs are usually broad and wide-spreading, and attached to them are dewclaws—small vestiges of hoofs (sometimes called "false hoofs") that are of some value on snow-covered terrain. The nose is covered with hair—an excellent protection against extreme cold.

Caribou are usually brown, paler and grayer on the back and darker

on the legs and head. The neck and the throat mane are white or whitish. There is considerable variation in height among these beasts —they stand anywhere from forty to sixty inches at the shoulder. The disparity in weight is even more striking; some weigh as little as two hundred pounds, others as much as seven hundred.

Rutting time for the Barren Ground caribou is in September and October, at the height of migration. The big-eyed, dappled fawns are born on the Arctic tundra during the seemingly endless "day" of June when every bank is a bed of gay spring flowers.

We have seen how abundant caribou once were, and have noted that they are as good as extinct in the United States. It is no exaggeration to say that the animal owes its continued existence today to the remoteness of its homeland. The caribou's habit of traveling in the open and its rather poor eyesight make it an easy prey for the hunter and the wolf.



THE REINDEER'S WILD BROTHER

To the Eskimos and northern Indians, the caribou is the staff of life: it provides choice meat, hide for clothing, and bones for weapons. A caribou with a broken limb, it is said, has the amazing ingenuity to withdraw to a sheltered island, away from the mainland where wolves would attack it. Here it remains till it is fit again. Pictured above is the woodland caribou, native to the northeastern United States and Canada.

There are several varieties of Barren Ground caribou, including the Greenland Caribou. A small, light-colored beast with slender antlers, it represents food, clothing, and shelter for many hardy people that live in desolate, frozen Greenland. The Dwarf Caribou of Queen Charlotte Island is a midget, comparatively speaking, as it stands no more than thirty-three inches high at the shoulder.

The Woodland Caribou, *Rangifer caribou,* is darker and more heavily built than the Barren Ground caribou. The antlers, though less spreading, are stouter and more flattened. These deer are found through the forests from the extreme northeastern tip of the United States to Great Slave Lake in Canada and Newfoundland. Related animals dwell in the Canadian Rockies and the Pacific coast region.

The Old World Caribou, *Rangifer tarandus,* and its relatives, once roamed from the Scandinavian peninsula eastward across Europe and through Siberia. Today they have almost disappeared in the wild everywhere but in the Siberian part of their ancient domain. However, these animals are still common in domesticated herds, as "reindeer."

THE "REINDEER AGE"

Wild or domesticated, reindeer or caribou have had an amazingly long association with man. It was the "Reindeer Age" that marked the dawn of human history.

In that period—it was twenty-five thousand to thirty thousand years ago—there were made, on cave walls, the first pictures that have come down to us. The artists, the "Reindeer Men" of the late Old Stone Age, left wonderful likenesses of contemporary animals—birds, snakes, horses, elephants, bear, bison, ibex, and oxen. But the best pictures of all were those of the reindeer—the most numerous big game in Europe and the principal support of man in that age.

REINDEER AND MAN

Just when was the reindeer first domesticated? There has been a great deal of dispute on the subject, but our earliest reference to a domesticated reindeer seems to be from a Chinese source dated A.D. 499.

It would appear that domestication was very tardy, if we are to judge from the fact that neither the Eskimo nor the Indian made

any attempt to tame this animal, which was so common in northern America. Domesticated reindeer, to be sure, have for a long time played an important part in the lives of the Tungus and Chukchi tribes in eastern Siberia. The animal is bred for riding, harnessed to sleds, and used for food. The Lapps and their Scandinavian neighbors milk their reindeer, churn butter, and make cheese from it.

Domesticated reindeer did not make their appearance in America until 1892, when 162 Siberian animals were landed at Teller, Alaska, for the benefit of hungry Indians and Eskimos. During the following decade, 1,118 more Siberian reindeer were transported to the shore of St. Clarence Bay. Well over a hundred thousand of the descendants of these imported animals have been killed for food and clothing.

REINDEER IN LAPLAND

Norway, Sweden, and Finland are reindeer countries, and the Lapps, who live in the northern regions of those lands, are staunch admirers of the great antlered creatures. Their philosophy is that the reindeer is more important than they are—the animals can get along without them, but they cannot get along without the reindeer.

The Lapps do not drive their deer, like other herdsmen. Nomads, they follow the herds from the summer feeding grounds to the winter ones, and draw their living from the beasts.

The reindeer is food, clothing, and transportation to these folk of the Far North. The hair is used by the Lapps to stuff mattresses; the hides are made into parkas, gloves, trousers, and shoes; the sinew is used for thread; and the stomach membranes come in handy as food containers and for packing cheese made from reindeer milk. Reindeer milk, by the way, is about four times as rich in butter fat as cow's milk, and a few drops will turn coffee white.

A reindeer team, pulling a sled, is a strange sight to those who have not seen it before; the Lapps harness up to nine or ten reindeer in single file to their sleds, each animal being tied to the one ahead by the reins. A single reindeer, as a beast of burden, can pack a load of ninety pounds. It can pull 450 pounds and travel forty miles a day. Of course this cannot be a continuous operation—the animal must have time out to rest and feed.

Reindeer prefer to travel into the wind even in the face of a bitter

arctic storm. When rounded up, they all mill around in one direction, either clockwise or counter-clockwise. A spectacle not easily forgotten is a sea of their horns whirling.

A FANTASTIC TREK

One of the greatest examples of human and animal endurance is found in the story of the great trek of Dan Crowley and Andrew Bahr. These men undertook to drive a herd of three thousand reindeer from the Selawik River in Alaska to Kittigazuit across the Mackenzie delta in Canada. On Christmas Day, 1929, the expedition started the long trek in the dim glow of the arctic light and headed north.

The distance Crowley and Bahr had to cover was actually no more than one thousand miles. But it was a thousand miles of unexplored wilderness—of snow-swept tundra and dangerous mountain passes. For months at a time, the men were lost and out of touch with civilization, which supposed that the entire outfit had perished from hunger and privation. Finally, the hardy travelers reached their destination. They had expected to make the trip in eighteen months; instead, it actually took them five years and two months!

How did the reindeer survive the journey? Crowley and Bahr delivered 2,370 animals in Kittigazuit. Only 10 per cent of these had been in the original herd that had left Alaska. The rest of that group had perished or been lost, but their places had been taken by youngsters born during the five-year trek.

ROE DEER—RACERS AND JUMPERS

The Roe Deer, *Capreolus,* is one of the smartest looking of the smaller deer of Europe and Asia. A pert, compact, and sturdy animal, its fleet figure may be glimpsed flashing through forest glades, especially in the mountains.

This alert woodlands creature is an excellent high-jumper; it is particularly graceful as it springs over tall ferns and heather. On even ground it swings along with an easy canter, head held high. When pursued, it often pauses to listen and look back, and is loath to leave cover. It can climb rocky cliffs with the agility of a chamois.

Though they are not sociable by nature, several roe deer may occupy a small area of woodland; it is not unusual for groups of three

or four to feed together. During the fall these animals tend to migrate from one feeding ground to another, and in Manchuria from three hundred to five hundred roe deer have been seen on the march together.

Perhaps it is some obscure and half-forgotten mating ritual, or just pure playfulness, that impels roe deer to gather in certain localities, where they gambol round and round after each other, wearing a circular track on the forest floor.

The doe brings forth her young in June, some forty weeks after mating. The fawns, usually twins, are marked with three rows of white spots on their tawny coats. The doe is very affectionate toward her babies and cannot stay far away when they are in danger. She is always on the lookout to protect her fawns or lead them to safety when enemies such as the fox or the golden eagle appear.

Roe deer stand from twenty-six to thirty-four inches at the shoulder and weigh about sixty pounds. Their horns are small (thirteen to sixteen inches long) and they rise abruptly together from the top of the head. The beam is very rough at the base, branching into a short forward prong and a longer rear tine that is forked at the tip.

Thick, harsh hair, brownish yellow in summer but duller brown in winter, covers the animal's body, while a bright white patch sets off the rump and stubby tail. The roe deer has a loud, sharp bark, something like that of a collie dog.

We meet the roe deer throughout Europe and across to the Pacific coast of northern Asia.

The Giraffe Family— Not All Are Skyscrapers

One of the most amazing sights to be seen on the African veld is a herd of giraffes moving at full gallop along the skyline. They travel with marvelous grace of form and rhythm of action.

Next to the trees the giraffes are the tallest living things on earth. Some of these beautiful, slender creatures are over nineteen feet high, and eighteen feet is not exceptional at all. The giraffe's shoulder height of twelve feet is rarely surpassed even by an elephant; and a man can actually stand upright between a giraffe's front legs.

In open country this animal can speed along at thirty-two miles an hour. But even when it comes to the bush, the tall giraffe is at no disadvantage—it does not need to slacken its speed. Instead, it swings along, swaying its head and long neck under the branches and in between the trees, without any danger of a crash.

Perhaps one of the reasons the giraffe swings along so gracefully is that when traveling it usually paces like a camel; the legs on the same side of the body move simultaneously. This produces an even, swaying motion akin to the roll of a ship riding the waves. Of course, the giraffe also walks, trots, and canters, as well as gallops.

Another trait that the giraffe has in common with the camel is that it does not show to advantage in the water. It is a poor wader, and is unable to swim. A deep river is an impassable barrier as far as the giraffe is concerned.

Dry, arid country, where the ground is packed firm and hard, is essential for the giraffe. In deep mud and swampy country it will bog down and become hopelessly mired. Even though its hoofs may measure twelve inches in length, they cannot support the huge, tall body on anything but solid ground.

GIRAFFES OF THE PAST

The giraffe's ancestors roamed Asia and Europe in primitive times, but they never reached America. In recent times, the modern giraffe has lived exclusively on African soil.

Europeans of long ago, having never seen a giraffe, thought of it as a legendary creature rather than a living animal. Its name comes from the Arab *zarafa,* with the twofold meaning: "a creature of grace," and "one who walks swiftly." In South Africa it was known as the *kameel,* and to the early Romans it was the camelopardalis, a mythical creature with a leopard for its father and a camel for its mother. The first giraffe to reach Europe was imported by Julius Caesar, who exhibited it in Rome in 46 B.C.

KINDS OF GIRAFFES

There are two very distinct types of giraffes. The common species found over most of Africa south of the Sahara is generally referred to as the Blotched Giraffe, *Giraffa camelopardalis.* There are eleven named local variations of the common giraffe. The Reticulated or Netted Giraffe, *Giraffa reticulata,* is the other, and more handsome, variety; we find it in East Africa. This creature has large, four-sided, liver-colored spots separated by a sharply defined network of narrow white lines.

A BIG, ATTRACTIVE CREATURE

Aside from being the tallest animal in the world, the giraffe comes close to being the third biggest in bulk, competing with the rhino for this honor. A large bull giraffe weighs two tons. A cow is two or three feet shorter than her mate, and weighs about twelve hundred pounds.

Almost as remarkable as the length of the giraffe's neck is the fact that it has no more bones in its neck than does a horse or a cow. The length of the neck is due entirely to the elongation of the bones—not to any extra vertebrae. The shoulders of a giraffe are of course much higher than the hindquarters.

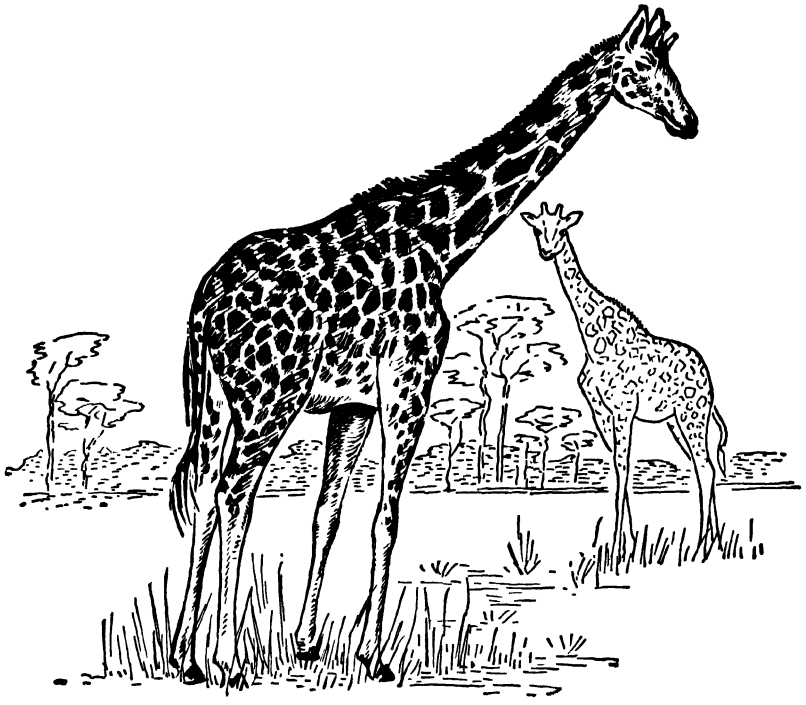
Both male and female giraffes have horns—quite short ones, covered with skin and hair, and tufted with black at the tip. Some giraffes of the northern species have a third horn, between the eyes, in front of the usual pair on the forehead. Not only that—old bulls often have a rudimentary second pair, in the form of low bosses, in back of the first pair.

The giraffe's large, dark-brown eyes, shaded by long black lashes, have a soulful, appealing expression. The giraffe has the keenest sight of any game animal in Africa; naturally its height allows it to command an extensive view.

A giraffe's lips are long, hairy, and prehensile. The long, extendible tongue measures up to eighteen inches in the adult. The neck is maned with short hair, while the comparatively long tail has a tuft of hair at the tip.

FRIENDS AND ENEMIES

Though the giraffe is a sociable creature, the herds are never large. Rarely do we find more than ten or fifteen giraffes together. These herds are cows with their calves and usually only one full-grown bull. Bulls that do not have a harem live alone or go about in twos or threes.



LONGEST NECK IN THE WORLD

The giraffe is the tallest animal on earth—a large bull may stand nineteen feet high. In the wilder parts of Africa the animal is cautious and shy, but in tourist-frequented regions it becomes remarkably tame and sure of itself. Its main enemy, besides man, is the lion.

A dangerous foe if put to the test, the giraffe can strike a smashing blow with its head, or deliver a terrific kick with its fore and hind feet. The customary lead attack is with the head.

BULL FIGHTS

In a duel between two bulls, each animal strikes for the chest and neck. Occasionally one giraffe will miss its mark and hit the ground

with a resounding thud. However, these thumping combats rarely have a fatal ending. True, a really well-placed blow from a hundred-pound head could conceivably break the opponent's neck. Giraffes have been seen with dislocated neckbones, and dead bulls have been found with a broken neck—probably the result of these battles.

A giraffe's horns are hardly serious weapons. Rounded and padded at the tip, they do not penetrate. Aside from relying on head blows, the giraffe makes good use of its forefeet when fighting ordinary foes. We have spoken of its "terrific kick"—remember that it is backed up by well over a ton of bone and muscle.

THE GIRAFFE'S MORTAL ENEMY

Aside from its own kind—and, of course, man—the giraffe has only one natural enemy in Africa: the lion. Even this dangerous assailant will attack only under certain conditions. First, the big cat must be pressed by hunger. Second, a single lion would not undertake to attack a full-grown giraffe; but two or more lions have been known to kill a mature bull. Finally, lions will strike only when the giraffe is vulnerable—when reaching down to drink. At such times, the giraffe has to spread the forelegs wide apart before its mouth can reach the water level.

The giraffe has a fairly long life expectancy; it has lived in captivity for twenty-eight years.

THE HARMLESS GIRAFFE

We can say of the giraffe that its character is blameless. It never hurts anyone or anything unless in defense of its life. Nor is it a menace to farmers or their interests in any way. Once in a while, however, it may prove a nuisance. Thus, in Uganda some years ago, six hundred miles of telegraph line went out of commission; four or five giraffes had run into the wires, nearly decapitating themselves. By raising the line to thirty feet, officials avoided further trouble.

The giraffe is fond of dry and open brush country; deep forest and swampy land are equally distasteful to this skyscraping creature. Trees are more or less essential for its livelihood, since it cannot graze on the ground, except with difficulty. Leaves and shoots of the acacia, the most common tree of the African veld, are this animal's

favorite food. And it is important to remember that against a background of acacia trees the markings on a giraffe resemble blotches of shadow and light—ideal camouflage for this tall animal.

The giraffe can do without water for quite a while—several weeks, even a month. Its ability to get moisture from leaves explains why it is sometimes found in the driest country, miles from water. Where water is readily available, it drinks regularly. A giraffe will drink about two gallons a week.

Even such a simple matter as sleeping becomes quite a problem for an animal with the giraffe's outsize height. Some grown giraffes (like some elephants) rarely lie down; they prefer to sleep standing up. They have found that all the bother of lying down and getting up again simply involves too much effort. This custom is not always strictly followed; in some regions, giraffes habitually lie down to sleep.

MUTE OR VOCAL?

There is a popular belief that the giraffe has no vocal cords and is therefore mute. The same is thought of a number of other animals—possibly because no one has happened to be around when they were exercising their vocal powers. In any event, the giraffe is not voiceless—we do have evidence of its uttering sounds. For example, a cow giraffe will produce a low call note when her calf strays out of bounds. In at least one case, a calf giraffe, ridden down on horseback, "blared" like a steer.

When Dr. Goss, veterinarian at the New York Zoological Park, performed an autopsy on a large bull giraffe, he found only undeveloped vocal cords. Yet this animal had uttered several groans or moos before dying! We may therefore say that the giraffe possesses ineffective vocal cords, but it can make sounds without them.

JUNIOR GIRAFFES

Giraffes seem to have no fixed mating season. The newborn calf, which arrives fourteen or fifteen months after the mating, is a mere five and one-half feet high. An ungainly little creature, it is all neck and legs.

Somewhat wobbly at first, a baby giraffe can stand and move around under its own power twenty minutes after birth, and is all

ready for its first meal. While nursing during the early stages, the calf braces itself between the mother's forelegs. For the first nine months, the calf is dependent on its mother's milk. After this it is tall enough to reach the branches of the acacia tree and feed itself.

Like all other young creatures, the baby giraffe loves to play and frolic. In a herd where there are several calves in the kindergarten stage, they are supervised by two or three watchful guardians. It is the grownups' duty to keep the youngsters from straying too far afield where they might be an easy prey for lions. If the frolicking of an overdaring youngster takes it out of bounds, one of the guardians will gallop off to bring it back into the fold.

THE MYSTERIOUS OKAPI

In natural history books published before 1900 there is no mention of the okapi—the animal did not become known to the white man before that date.

Many years ago pygmies living in the dense forest of the Congo told of a strange, elusive creature inhabiting their country. They described it as being built like a giraffe, striped like a zebra, and with large ears like a donkey. Hunters and explorers who visited these remote jungles, where tangled vines and dense forest growth blot out the sun for miles and miles, could never even get a glimpse of these seemingly mythical creatures.

Finally, the little brown people produced a skin of the animal. Here was tangible proof that what they had been speaking of was no phantom of the imagination. The white man's curiosity was now thoroughly aroused and his reputation as a scientist was at stake. What would the animal prove to be?—some kind of a horse, was the first guess: or perhaps an antelope.

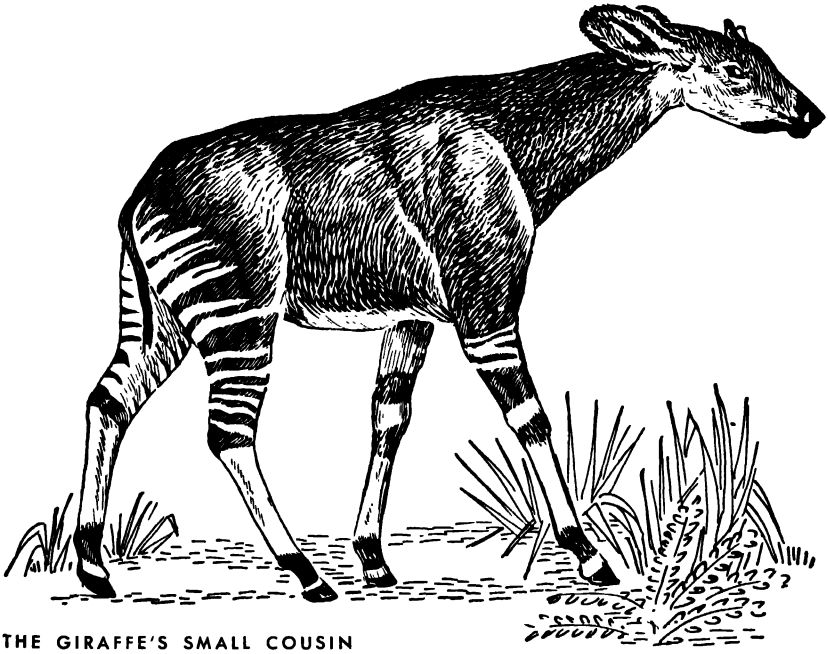
But the suppositions were all wrong. The animal turned out to be more closely related to the giraffe than to any other living animal. The little brown men were vindicated—as anyone who had had dealings with the pygmies should have expected they would be.

GIRAFFES AND OKAPIS

The earliest giraffes, which lived about fifteen million years ago, were the common ancestors of our modern giraffe and okapi. Today

both of these creatures are grouped in the family Giraffidae, even though the okapi's neck is nowhere near as long as the giraffe's.

The relatively short-necked okapi is the "normal" member of the giraffe family. The primitive giraffes of millions of years ago—we call them "palaetragines"—looked very much like the okapi of today, resembling it in size and general structure. It is the elongated skyward animal—the typical giraffe—that is the oddity of the family. Through the ages the giraffe developed a longer and longer neck, becoming more and more unlike its ancestors. The okapi, on the other hand, advanced along a conventional course, following conservative lines in its development.



THE GIRAFFE'S SMALL COUSIN

Although the okapi is a fairly familiar sight in zoos, where it quickly makes itself at home, this creature of the dense African forests was almost unknown to science before 1900. A peculiar-looking animal, the okapi has a shorter neck than its close relative the giraffe, and is smaller than an ox in size; stripes on its upper legs add to its strangeness.

THE DISCOVERY OF THE OKAPI

For years, as we have seen, this strange mule-like animal was known only to the forest pygmies of Africa. The first rumors of its existence

that were to receive serious attention came to the famous journalist and explorer Henry M. Stanley. He passed on the story to Sir Harry Johnston, at that time governor of Uganda. In 1899 Sir Harry obtained a few scraps of skin of the mysterious animal from the natives. He sent on the evidence to Dr. P. L. Sclater in London, who conjectured that they might belong to a hitherto unknown variety of zebra.

Two years later Sir Harry secured a complete skin and two skulls of this legendary creature—the only large animal that had escaped the notice of science until the twentieth century. The discovery created a furor among zoologists throughout the world. Dr. Sclater named the animal *Okapia johnstoni*, in honor of the governor. It was not until August 3, 1937, that the first living okapi to reach American shores arrived at the New York Zoological Park.

THE OKAPI AT HOME

The okapi lives in deep forest country, yet its vision is not very well suited for the dim light that filters through the dense vegetation of its favored surroundings. Luckily, its keen senses of smell and hearing compensate for this failing.

When disturbed, the okapi gallops away, carrying its head forward in line with the body; it can keep up a fast pace for long distances. A leaf-eater, the okapi browses on forest trees. It is often solitary, though sometimes two may be seen together. The single baby is built like the adult and has the same unusual coloring.

The okapi's color is distinctive, with the body and neck a rich dark-brown, and the head buffy white. The markings on the hindquarters are unique—slantwise stripes of black and white. The lower limbs are white with a narrow black band. The comparatively long tail ends in a tuft of hair.

Resemblances to the Giraffe. The okapi's tongue, like the giraffe's, is extendible, and the lips—again like the giraffe's—are prehensile. Thus the tongue and lips are adapted for picking foliage. There are also resemblances between the two animals in the teeth. The feet are of the regular even-toed hoofed-mammal type.

Although the okapi's limbs and neck are relatively long, they have none of the exaggerated qualities typical of the giraffe. The body is

short and compact, and the hind limbs give a deceptive impression of being much longer than the front limbs. The male okapi stands a bit over five feet at the shoulder; the female is smaller.

The Okapi's Horns. One of the most striking resemblances of the okapi to the giraffe is found in the horns. In the okapi, they have a maximum length of five inches, and are covered for most of their length by hair. Unlike the horns and antlers of deer and antelope, the okapi's horns do not grow out from the skull. They actually are independent of the skull before birth, being within the flesh; later on they grow downward and become firmly fused to the skull. This is also true of the horns of the typical giraffes.

The okapi's favorite haunts, so far as we know, are in the Semliki and Ituri forests of the upper Congo in the African equatorial zone.

Pronghorns–America's Swiftest Runners

In the early pioneering days of America, the pronghorn was as much a part of the West as the buffalo, Indian, and the prairie dog. Natural enemies may have taken a limited toll of its numbers, and the Indians—still without horses in those days—no doubt killed a few pronghorns with bow and arrow. Still, when the white man arrived, the pronghorn teemed on the western plains in herds of many thousands.

Of all the living hoofed mammals, the pronghorn is among the few—possibly the only one—whose ancestors were American and did not emigrate from the Old World in remote ages. The original pronghorn country extended from the southern junction of Saskatchewan and Alberta in Canada, through the region southwest of the Mississippi valley, to central Mexico. Today we find the animal only in a few favored sections of the upland plains in the Rocky Mountain area.

REMARKABLE HORNS

The pronghorn is distinctive, above all, for its unique horns. Like the horns of sheep, goats, and antelope, they are hollow and composed of a sheath that covers a bony core. Despite this similarity, the pronghorn's horns are different in two ways.

One difference is that the horns of this animal are pronged (hence its name). None of the other hollow-horned hoofed mammals have this feature. We might accept this branching of the horns as a reasonable variation of the hollow-horned group if it were not for the second remarkable difference; while the others keep their horns for life, the pronghorn sheds its horny sheath every year.

The entire outside sheath is eased off the bony core by the formation of the new horn underneath, and is shed in the fall soon after the rutting season has ended. The new sheath begins to grow from the tip of the core, and spreads slowly downward until it reaches the base. During the time it is growing, it is covered with skin and hair, which are lost when the horn matures and hardens. Both bucks and does have horns, but the females have smaller and more slender ones than the males. In fact, some does lack horns altogether.

THE PRONGHORN'S WARNING SIGNAL

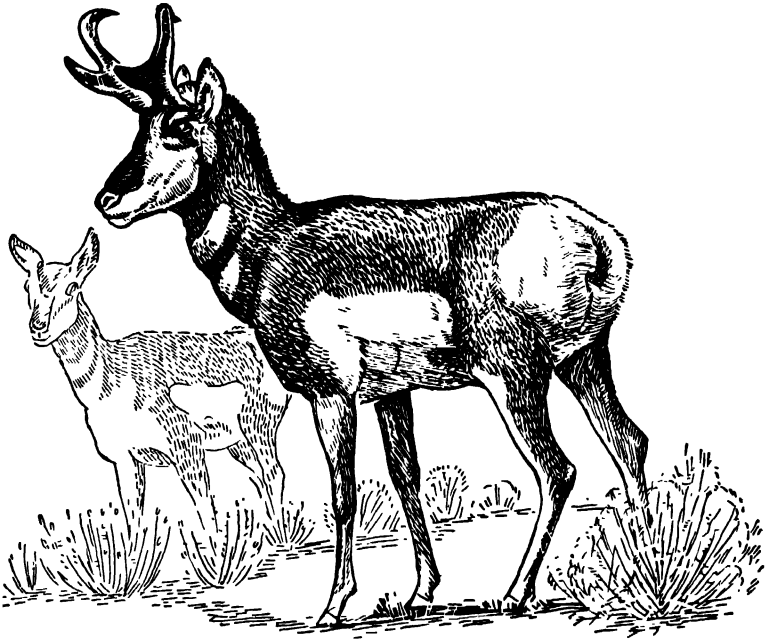
Most animals have some means of communicating with their fellows. This is especially true of the social creatures that live in herds. The pronghorn's signal is one of the most remarkable pieces of nature's handiwork—it is quite silent.

This is how it works. The hairs on the animal's rump are white and longer than those found anywhere else on the body. The roots are embedded in special muscular sheaths, which make it possible for the pronghorn to erect the rump hairs at will in the shape of a great rosette.

When the animal raises this white rosette or shield, it reflects an incredible amount of light. The shield is especially brilliant if flashed in the bright sunlight, and can be seen from a distance of nearly four miles. Sensing danger, the pronghorn transmits its fears by this flashing signal, thus alerting the pronghorns and other animals in its vicinity. The pronghorn usually travels without making a sound.

A FAMILY ALL BY ITSELF

It is true that we often refer to the Pronghorn, *Antilocapra americana*, as the pronghorn "antelope," and that in a general way it does resemble an antelope. Yet the pronghorn is not an antelope. It shows certain traits of deer and cattle, but, for all that, it does not belong to either of these families, nor is it closely related to any other group of animals found under the heading of even-toed hoofed mammals. And so scientists have had to allot the pronghorn a family all to itself, the Antilocapridae.



THE MUCH-HUNTED PRONGHORN

Wildlife experts estimate that North America was once the home of forty million pronghorns, today, only a few hundred thousand of these handsome, harmless antelope-like creatures remain in the Far West. Pronghorns are fleet of foot, but they are also possessed of great curiosity, and so they are easy victims for the man with the gun.

AN INSULATED COAT

Living as it does on the great open spaces, where there is no shelter from bitter winter winds, the pronghorn has a special insulated coat

that helps to conserve body heat. This covering is made up of long, tightly packed hair, full and deep. Each hair is a hollow tube filled with a pithlike substance. A rich reddish brown or tan, the coat is darkened on the mane along the neck with blackish brown.

The pronghorn is medium sized, as animals go. Grown bucks measure thirty-two to forty inches at the shoulder, and weigh from one hundred to 125 pounds; females average 10 per cent smaller in size and weight. Specially adapted for travel over hard, arid plains and upland plateaus, the pronghorn, unlike most other ruminants, has no small "extra" hoofs (dewclaws) on the back of its foot.

With a top speed of nearly a mile a minute, the pronghorn is the swiftest runner in America. In fact, in the whole world, it may rank second, next to the cheetah of India. Pronghorn dry does (does that have borne no young), by the way, are fleeter than the bucks.

PRONGHORN ENEMIES

Though the coyote, wolf, cougar, and eagle are among the pronghorn's natural enemies, snow is its most dreaded foe of all. Deep snow deprives the pronghorn of its natural food supply—grasses, brush, and the like. Moreover, it causes the animal to founder as it attempts to forage. At the same time, the deep snow drives the wolves and coyotes frantic with hunger.

During excessively cold and snowy winters, pronghorns starve to death by the thousands. During the fearful winter of 1893, when the temperature fell to 61° below zero at Fort Assiniboine, Montana, nine hundred antelope perished in the deep drifts near the post.

PRONGHORN MATING AND THE YOUNG

Pronghorns mate in the fall, usually in September. During the rutting season, the larger bands split up into small groups—generally a buck with three or four does. Like the males of most of the deer family, the mating pronghorn bucks are truculent and savage, fighting fierce battles for possession of the does. Once the rut is over, all live peacefully together.

About eight months after the mating season, late in May or early June, twin fawns or, occasionally, triplets are born. Baby pronghorns

develop fast. When only a few days old, they can dash away at twenty-five miles an hour.

Hiding is the best precaution against danger, as far as the little ones are concerned. The wise old mother stations her twins about a hundred yards apart, remaining away herself except at nursing time, and they lie hidden in the tall grass until her return. She is seldom far off, and keeps a watchful eye open for a prowling coyote or a hunting eagle; if such an enemy appears, she will try to lure it away, distracting its attention from her young.

Despite the extensive hunting of the past, these animals, aided by conservation policies, seem to be holding their own. In recent years, the pronghorn population has come close to three hundred thousand.

Buffaloes, Wild Cattle, Yaks, and Other Oxen

THE OXEN, or cattle, are the most important members of the animal kingdom so far as man is concerned, for they supply him with meat and milk in great quantity. You will search in vain among these beasts for a purple cow:

I never saw a purple cow,
I never hope to see one;
But I can tell you anyhow,
I'd rather see than be one.

That animal appears to have been thought of for the first time around the turn of the century (1897) by an American writer of light verses, Gelett Burgess. But other kinds of cows and cattle there are in abundance, and many, especially in the wild, are fascinating creatures.

The Egyptians and Babylonians were among the early peoples that used oxen for their needs. They milked their cows as early as 3,000 B.C. However, man kept oxen long before the Egyptian civilization arose; he may have used them originally for sacrificial purposes. The ancient Chinese harnessed the oxen as beasts of burden, but they never milked any of their female animals.

CATTLE FOR THE NEW WORLD

In olden times, the Spaniards were noted for their cattle and for their passionate interest in bull fighting, a sport that goes back to the ancient Cretans. Columbus, on his second voyage in 1493, seems to have brought the first cattle to America. However, the first reliable record we have is of a number of calves from Santo Domingo, which were landed near Veracruz, Mexico, in 1521.

The Texas longhorn, once so popular in the southern United States and Mexico, originated from a type found in Spain during the fifteenth and sixteenth centuries. This animal's horns are so long that it is not easily transported. After 1860, the Hereford rapidly—and completely—replaced the Texas longhorns on American ranges. Herefords are red cattle with white faces and long horns. When grass of good quality is available, they are soon fattened and ready for market.

(Incidentally, Texas probably holds the world's record for the largest domestic ox—an animal that weighed over twenty-eight hundred pounds.)

SOME FAMED BREEDS OF CATTLE

Though the domestication of cattle goes back thousands of years, it is only in comparatively recent times that man has achieved miraculous results by selective breeding. Consider, for example, the Jersey cow, which yields over five thousand pounds of milk of the finest quality in the course of a single year. Even more remarkable, perhaps, is the Holstein variety, so productive that it furnishes its own weight in milk in two weeks.

No less noteworthy have been the results achieved in breeding cattle for their meat. Aside from the Hereford, which we have already mentioned, there are such notable breeds as the Shorthorn (which also produces abundant milk) and Aberdeen-Angus.

THE FAMILY OF THE OXEN

Although, from the human standpoint, the oxen are the most valuable members of their family (Bovidae), that family includes other groups of animals that are of the greatest economic importance to us.

There are, for example, the goats and sheep. The domestication of these two animals goes back some five thousand years; for much of that time, people all over the world have been dependent on them for food and clothing.

The antelopes, limited to Africa and Asia, make up a fourth group. They are handsome creatures, still in the wild state with one or two minor exceptions; they are favorite game animals.

Finally, the family Bovidae includes the goat antelopes, animals that live in almost inaccessible mountain regions. As their name indicates, they share some of the characteristics which we associate with goats and antelopes.

For the most part, the Bovidae are an Old World family, well represented in Asia and Africa and only moderately so in Europe. No members of the family are native to South America, Australia, or Madagascar. North America has only a few Bovidae, but they are spectacular beasts—the musk ox, the almost legendary bison, the Rocky Mountain goat, and the bighorn sheep.

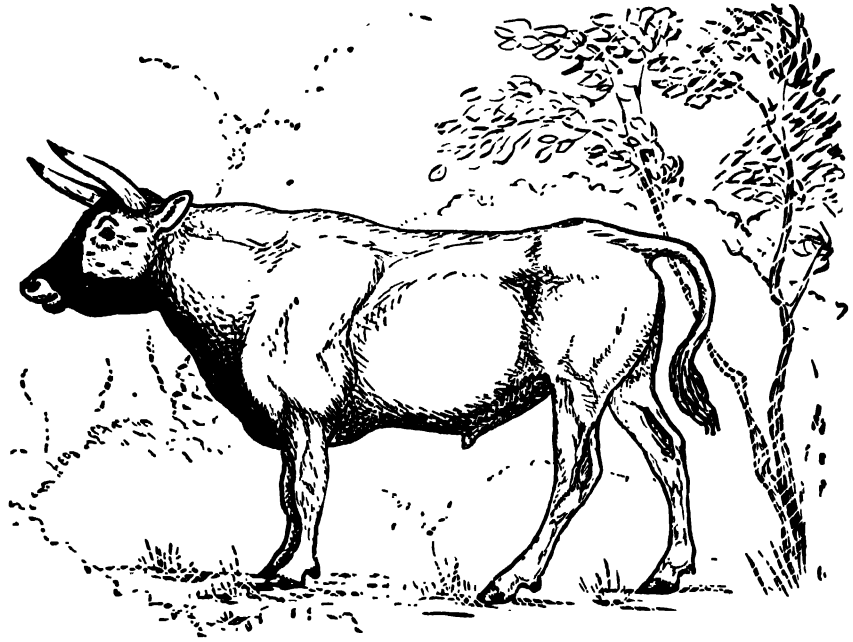
A word about the Bovidae in general. They all have cloven hoofs—that is, they are even-toed. They are ruminants, or cud-chewers. All have permanent horns, simple and unbranched. These consist of a hollow horny sheath growing over pointed bony cores that arise from the front of the skull. (American frontiersmen used to separate the sheath from the core and use the former as a powder horn.) The horns continue to grow throughout the life of the animal and are never shed. Always occurring in pairs, the horns are often—though not always—present in both sexes.

We turn back now to the first group of this great family, the wild oxen.

WILD ANCESTOR OF OUR CATTLE

The tame cattle of today are descended from wild ancestors. One of the most interesting was the Aurochs, or Urus, *Bos taurus primigenius,* once found in many parts of Europe and in northern Africa

from Egypt to Morocco and Algeria. This large beast—it stood six feet at the shoulder—had disappeared in Britain before the arrival of the Romans (who elsewhere referred to it as *Bos urus),* and became extinct as a wild animal early in the sixteenth century; the last known specimen died in Poland in 1627. The aurochs was once plentiful in Palestine; it appears to be mentioned in the Bible as the "unicorn."



WILD OX OF THE ANCIENT WORLD

The aurochs or urus, ancestor of our present-day domestic cattle, once roamed much of Europe and northern Africa. Well known to the ancient Israelites, the aurochs is mentioned in the text of the Old Testament several times. This creature is now extinct—the last aurochs appears to have died in 1627. (Its name is sometimes applied to the wisent, or European bison, an entirely different animal.)

WATER BUFFALOES

A tremendous fellow, the Asiatic Buffalo, Carabao, or Water Buffalo, *Bubalus bubalis,* fears no living thing in its native jungle. There have been occasions where a water buffalo disputed the right of way with an elephant! Even the huge rhinoceros is more discreet—at least in respect to challenging an elephant's right of way.

Savage and unreliable in disposition, especially when aroused, the water buffalo is an extremely dangerous animal to stalk. This is due in some measure to the dense cover in which it is found, but even more to the fact that this behemoth has comparatively little fear of man and seems to be able to sense when it is being followed. It will take the offensive against a tiger, and—what is still more impressive—it is capable of besting the big cat in a duel. Like the tiger, the water buffalo is hunted in India from the back of an elephant.

STARTLING DOCILITY OF TAME WATER BUFFALOES

Bred in captivity, the water buffalo is very different from its wild relatives. The domesticated animals are so gentle that they can be driven in herds by native children. What makes the contrast in disposition even more amazing is that you generally cannot tell the wild from the domesticated varieties, as far as mere appearance is concerned.

We find the domesticated buffaloes all the way from Egypt to India and the Philippines. (The Borneo Buffalo, a smaller-horned cousin, dwells in the river valleys of northeast Borneo.) The taming of the water buffalo goes back to at least 3,000 B.C. From then on, it was introduced in many of the warmer parts of the Old World.

Although the water buffalo's milk has a high butter-fat content, the animal is not so important as a dairy animal, since its supply of milk is rather scanty. On the other hand, the cowlike tractability and docility of the domesticated buffaloes qualify them as useful draft animals, and they have been pullers of ploughs and carts since ancient times.

HUGE AND POWERFUL

The huge water buffalo exceeds all the oxen in size—a large bull stands five feet at the shoulder. As for the horns, they are the largest in the whole Bovidae family. The shape of these horns varies somewhat. The typical ones are rough and flattened, sweeping out from the sides of the head in a wide arc. However, some water buffaloes have horns that are nearly straight at the base and turn up only near the tips. Measured along the curve, the greatest recorded length for the horns of this species is a trifle over seventy-seven inches.

Heavily built, this powerful animal has stout legs and a long tail

ending in a brush of stiff hairs that serve as a fly-swatter. The muzzle is large and square, the head is carried low. Scantily haired, the water buffalo's hide is dark ashy-gray, almost black, in color.



THE UNTAMED WATER BUFFALO LOOKS DECEPTIVELY PEACEFUL

Seen standing in its favorite spot, a waterhole—hidden among tall grasses—the Asiatic buffalo or carabao looks like a docile if not sluggish animal. Yet it will on occasion pit itself against even the lordly elephant and the savage tiger. It shows little fear of man. Domesticated, the water buffalo is a marvel of meekness and reliability.

The water buffalo, as we might gather from its name, loves the water and is never so happy as when it is wallowing in a soft mudhole. Here it will stay for hours during the heat of the day, with only its eyes and nostrils exposed, blissfully softening its thick hide in the ooze. In the water it is safe from torment by the hordes of biting fleas and other insect pests.

BULLS AND COWS

Old bulls are usually solitary, having their own particular home territory and guarding it zealously against all newcomers. In general,

however, cows and their calves associate with a bull in herds of various sizes. Cows have one or two young at a time during the summer, ten months after mating.

We still find the water buffalo in the wild state in northeastern India, Ceylon, and parts of Indo-China and the Malay Peninsula. It favors tall-grass country and reed beds that border watercourses and swampland.

SOME ISLAND BUFFALOES

The Tamarao, or Philippine Pygmy Buffalo, is a small buffalo of the southern Philippine Islands. Its short, stout horns are about twenty inches long. Frequenting thickets and marshes along watercourses, it also dwells in bamboo forests in the mountains up to altitudes of six thousand feet.

The Celebes Anoa, or Pygmy Buffalo, is the smallest of the wild cattle. It has shorter and straighter horns than the tamarao—they rarely reach a length of fifteen inches. We are told that the Celebes anoa lives alone or in pairs, frequenting the wooded mountain slopes in the Celebes.

SACRED CATTLE

The Zebu or Humped Cattle of India, *Bos indicus,* are held sacred in their native land—especially by the Brahmins. Following the tenets of Hindu faith, the bull is dedicated to Brahma, the supreme creator. When branded with the mark of Siva, the four-handed deity of destruction, this bull is allowed to wander where it pleases. No Hindu would dare object, even should it take a fancy to the vegetables in his garden or even in his shop. (Some monkeys enjoy a similar status to the zebu in India.)

The zebu are probably of aurochs stock, and were domesticated in Asia by 4,000 B.C. Divided into many breeds, they differ mainly from European cattle in having a much enlarged fatty hump on the shoulder. Usually they possess a big dewlap, short horns, and long ears. Some breeds are much smaller than the typical ox.

Throughout India, people hold the oxen in high esteem and they rarely eat the flesh—except that of an animal that has died. It is not unusual to hear a native call a dear friend of his "my ox."

India is not the only home of the humped cattle. They are also found in China, the East Indies, and East Africa. In these areas the animals are kept for meat and milk, for riding, and as beasts of burden. Humped cattle have been introduced in Texas and other places, where they have been crossed with other breeds, producing a variety of animal that can resist Texas fever, an infectious disease of cattle.

FAMOUS "WILD CATTLE" OF BRITAIN

One of the mysteries of science are the famous so-called "wild cattle" of England's Chartley Park and Chillingham Park, and Cadzow Castle in Scotland. Although these oxen closely resemble some of our finest modern breeds, they are fairly wild creatures, having been kept in surroundings much like those that wild cattle enjoy in nature.

No one is sure where the "wild cattle" originated. Some have said they were half-tame descendants of the aurochs, but this is doubtful. We do have records of herds of wild white cattle that roamed England long ago, and they may have been put into enclosures as the woodlands were cut down.

It was reported of the white cattle of Chillingham Park that they had a number of savage traits. The cows kept their young in hiding for seven days or longer after they were born. The bulls were said to engage in combat over a likely female, and once in a while one of the contestants was slain.

As a schoolboy, the author lived near the place where the Chartley wild cattle were kept. They had a very picturesque appearance, with their coats snow white except for the feet, ear tips, and the end of the nose, which were always jet black. At first there were forty of these animals, but their number gradually dwindled until only one big bull and a cow were left.

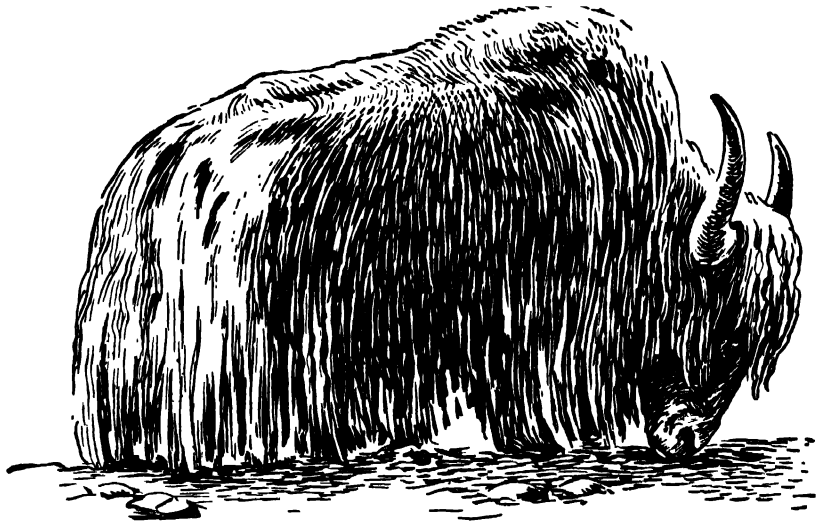
One Sunday morning the schoolboy crept up behind that last big bull and breathlessly tied some strands of the hair of its tail to the park railing. It was a tense few minutes until the boy reached safety. Later he returned and found some of the bull's hairs still attached to the railing. That was over forty years ago. The last time the author was in England, he came across that bunch of long white hairs, duly tagged and labeled, in his old desk. It is an interesting memento, for the Chartley herd has become extinct.

YAKS, OR GRUNTING OXEN

The Yak or Grunting Ox, *Bos (Poephagus) grunniens,* got its second name from the gruntlike sounds it makes, especially when it is loaded beyond comfortable capacity.

In the wild, the yak frequents the plateau of Tibet, among the coldest and most desolate parts of the world, at elevations of fourteen thousand to fifteen thousand feet in winter—up to twenty thousand in summer.

The domesticated yak, a somewhat smaller animal, has served its country well—it might almost be taken as a symbol of Tibet. This buffalo-like animal is milked (Tibetans have many uses for rancid yak butter, and are fond of it in tea), ridden, driven, and carries heavy loads over mountain passes. In this lofty land where there are no automobile roads and the people are not governed by pressure of time, the yak can fulfill almost all their transportation needs.



HAIR SO LONG IT SWEEPS THE GROUND

Easy to recognize is the yak or grunting ox, with its long, smooth hair growing down over its entire body, hiding the feet. Tassels of hair even obscure its eyes and ears. Found only in the remote fastnesses of Tibet, the yak, when domesticated, is highly valued for its surefootedness and ability to carry heavy loads up steep inclines.

A MASSIVE BEAST

Large yak bulls are nearly six feet high at the shoulder and weigh twelve hundred pounds. The legs are short, with large, rounded feet, and the muzzle and ears relatively small. Smooth, round horns curve upward, outward, and then forward. The hair on the back is smooth but very long on the lower parts, hanging from the sides of the body in a long, sweeping fringe. (Yak hair is widely employed by the Tibetans, and a team of yaks may be harnessed by rope made of their own hair.) The yak's general color is dark brown, almost black, throughout—except for a little white on the muzzle.

The Yak's Tail. The yak's tail has a thick tassel of long hair. At one time this plumed tail was in great demand; it was used in the headdress worn by officers of state to denote their rank. The tails were also dyed, mounted on a saber handle, and used as fly swatters. Many of the domestic animals, such as the plow yak (all plowing in Tibet is done with yaks) are now tailless—the tail has been cut off and sold.

SURE-FOOTED AND HARDY MOUNTAINEERS

Yaks feed in the early morning and evening on the rough, wiry grass that grows in the upland valleys. During the day these sure-footed and hardy mountaineers retreat to rest on the steep, barren hillsides, where they command a wide view of the surrounding country. Their sight and hearing are not exceptionally good, but they do have a well-developed sense of smell.

During the summer, cows and calves collect in herds of ten to one hundred. The bulls are more or less solitary, except during the rut, when each bull separates four or five cows from the herd. Mating takes place in winter, and the calves are born in the autumn, ten months later.

GAURS—INDIA'S "BISON"

The Gaur, or Seladang, *Bibos gaurus*, is among the largest of wild cattle. This forest animal, the so-called Indian "bison," attains a height of over six feet at the shoulder, and has a head and body length of nine feet, six inches.

Like the yak, the full-grown bull is dark brown, almost black, though the legs from the knees and hocks down are white. The upturned horns are broad, heavy, and tipped with black.

The cows, which are smaller than the bulls, stand about five feet high at the shoulder and their coloring has rather a reddish cast. The gaur's body is deep through the chest and very massive, with a high ridge from the neck to the middle of the back.

Grasses and shoots of the bamboo and other trees make up the principal diet of the gaur, which keeps to the forest and tall grass, generally near the hills, in India, Burma, and the Malay Peninsula. A shy and timid animal, this sizable creature travels in small herds of five to twenty or more.

Most of the natives and hunters agree that the gaur is a very inoffensive creature, rarely attacking anyone; the bull which has been expelled from the herd may, however, be inclined to make trouble. A wounded animal is also dangerous. Hunting the gaur was a favorite sport of the Englishman in India; if his first shots did not kill the gaur, the hunter sometimes had to face the deadly rush of the agonized beast.

Attempts to raise the gaur as a domestic animal have failed—unless, of course, it could be proved that the gayal (described later) is a breed of gaur. Calves always die in captivity before they grow up.

The natives of Malabar have a rather fanciful legend about the gaur. They assert that it will pick up stones in its nostrils and discharge them at adversaries with the force of a musket ball; that their aim is so accurate that the wound is always mortal.

The Gayal, or Mithan, *Bibos frontalis,* dwells in the same forests as its big cousin the gaur, but depends on man for its food. The animal is very similar in color and general appearance to the gaur, though somewhat smaller, with shorter limbs and a less pronounced ridge on the back. The horns are broad and heavy, but nearly straight instead of curved like those of the gaur. The range of this species of cattle includes the hills of Tipperah and the regions south of the Assam Valley in India.

The gayal is used by the natives for food and for its milk; we have reason to believe that the gayal is actually a half-domesticated race of the gaur.

OTHER INTERESTING WILD OXEN OF THE EAST

The Banting, or Tsaine, *Bibos sondaicus,* the typical wild ox of the Malay lands, resembles a Jersey cow more than anything else. Much smaller, lighter in color than the gaur, and even more timid, it has been successfully domesticated by the natives.

The common banting lives in Java, but it has close relatives throughout southeastern Asia. It has much the same habits as the gaur, though it prefers low-lying grassy plains and bamboo forests to the more hilly homeland of the gaur.

The Kouprey, *Bibos sauveli,* is also known as the Gray Ox and Indo-Chinese Forest Ox. Strange as it may seem, it escaped the attention of science until a little over twenty years ago, when a living specimen was sent to the zoological gardens in Paris.

Another interesting thing about the kouprey is that the horns of the adult male burst open at the tip, exposing about five inches of an inner black horn.

A typical oxlike animal, the kouprey is over five feet at the shoulder. Its head and body length is eight feet, and the tail is quite long—over three feet. The hair is short, close, glossy, and blackish brown in color, with occasional white markings down the back. The feet are usually white.

The kouprey, so far as we know, is found only in Cambodia and Laos.

AFRICAN BUFFALOES

CAPE BUFFALOES—SAVAGE WHEN ROUSED

The Black or Cape Buffalo, *Syncerus caffer,* is suspicious but inoffensive when unmolested. Hunted, it becomes wary and usually seeks safety in flight. When persistently stalked, and especially if it is wounded, the animal will hide in the bush, then savagely charge the hunter when he approaches within twenty feet of the ambuscade. At such close range, almost nothing less than a smashing direct hit in the brain will stop the fierce onslaught of the maddened beast.

The Hunter Hunted. One fiction writer on African bush lore tells a most amazing story about the ferocity of the black buffalo. A hunt-

ress entering the country of the Masai tribe was attacked by a large bull. When she fired at the charging animal, the bullet grazed the shield of its horns and only creased the top of its head. This infuriated the animal to an even greater degree.

The woman barely had time to dismount her horse, which took the brunt of the charge. Taking refuge up a small thorn tree, she saw the horse gored to death. As she watched in horrified silence, the maddened bull, with deep, guttural roars, trampled and ripped its victim until the veld was spattered with blood and gore. Then, instead of making off, the bull sniffed the air for the rider. Presently he located the tree in which the woman clung. Vainly he tried to dislodge her by repeated charges at the tree.

The woman, who had long experience in hunting, prepared to spend the night in the tree. It swayed as she strapped herself with her belt to a high branch, but she was safe enough—or so it seemed. Now comes the most incredible part of the story.

The least of the black buffalo's virtues is persistence. Finding he could not shake her or hook her down by plunging upward in the air, the bull discovered there was another way to get at her—that by stretching his neck and head to the fullest extent upward, he could reach the girl's bare legs with his long, rough tongue.

The girl could climb no higher—her knees were already pressed under her chin. Having reached her limit, she fearfully realized the things a buffalo can do with its tongue. With horror she recalled what had happened to others in the same predicament. Native folklore tells of many such tragedies.

Next morning she was found with the flesh gone from both her feet—licked away to above her ankles by the rasplike tongue of the beast. When help came, the gory bull was still standing beneath the tree, the blood dripping from his mouth and nose. The buffalo paid with his life, but that night the girl died through loss of blood.

We might be tempted to write off this story as a product of the author's imagination. However, Afrikanders who have read the story and are familiar with the ferocious nature of the Cape buffalo, concede that such an incident could be true, or that it is within the realm of possibility.

Remarkable Horns. The Cape buffalo is a large, thickset black buffalo with massive horns, a short head, and large, fringed ears. The broadly

flattened horns arise close together on the top of the head, where they form a helmet-like shield, then extend backward and outward, curving up evenly to a sharp point.

Viewed from above, the horns are somewhat like triangles—very broad at the base (sometimes more than twelve inches) and tapered sharply to the tip. The total length along the outer curve of the horn is up to thirty-nine inches. A full-grown bull stands about five feet high at the shoulder and weighs about fifteen hundred pounds.

Where the Cape Buffalo Lives. The ideal dwelling place for the Cape buffalo contains an ample supply of water, a large pasture of grass and reeds, and a background of forest or jungle for shelter. Under such conditions, herds may range from fifty up to a thousand.

African buffaloes feed during the early morning and late evening and often at night, but they rest in the bush during the heat of the day. Usually the buffalo is a very silent creature and large herds,



HUNTERS, BEWARE THE ANGER OF THIS BUFFALO

Unmolested, the Cape or black buffalo of Africa keeps to itself and harms no one. But when it is hunted down, and particularly if wounded, it fights back with maddened and bloody fury. On this animal's handsome head rests a magnificent pair of horns—each may measure over three feet in length.

when feeding, never make a sound. The buffalo will bellow when attacked by lions. However, they prefer to hunt the cows and calves rather than the big-horned bulls that can put up a terrific battle against a single lion.

Cape buffaloes have a normal life span of at least sixteen years; some have lived ten years in captivity. The mating season starts in January, and the calves are born eleven months later.

The African buffalo is spread over most of Africa south of the Sahara, but disease and hunting have greatly reduced its numbers. Like most other big game, this buffalo suffers severely from rinderpest, which is spread by the domestic cattle of wandering natives. On one occasion, a rinderpest epidemic practically reduced to zero the entire buffalo population of Kenya Colony for nearly twenty years.

The Dwarf Forest Buffalo, *Syncerus nanus,* sometimes called the Bush Cow, dwells in the forested regions of central and western Africa. A distinct species, it is much smaller than the Cape buffalo. The shoulder height is about four feet, the dressed weight about 580 pounds. The coat is typically red, but bulls turn black with advancing age. The horns, flattened at the base, are directed in a backward curve and do not exceed thirty inches in length.

BISON—ONCE THERE WERE MILLIONS

The American Bison, or Plains Buffalo, *Bison bison,* once roamed the North American plains in vast herds of as many as four million individuals. One single herd would cover an area twenty-five miles wide and fifty miles deep. The total number of bisons in North America at the time the white man arrived has been estimated at sixty million. By 1900, only three hundred of these huge creatures were left in the United States. Today there are several times this number in Yellowstone National Park, where they are prospering.

Civilized man has never beheld a greater concentration of big game than the buffalo herds in their heyday. Not only the Indians, but the early western settlers as well, depended largely on the buffalo for their livelihood. The great beast furnished the materials for food, clothing, shelter, and heat.

In the end, the very profusion of bison led to their downfall, as we shall see later on.

CLIFF STAMPEDES

The Indians used to make a practice of stampeding herds of bison over a cliff. Perhaps the most famous of these natural death traps for the bison was Buffalo Jump-off in the valley of the Yellowstone, Montana. In its day this cliff was a primitive form of the slaughteryards of Chicago, as the Indians periodically drove the herds over the brink.

The Indians made robes of the buffalo's hide. They cut the meat into thin strips, which they smoked and dried; it was known as "jerked meat" or "jerky" and was almost as hard as a rock. They carried it on journeys, and, when they wanted to eat it, pounded the strips into powder and mixed them with berries and fat. This fare went under the name of pemmican. By way of contrast, today's pemmican, used by explorers, is likely to contain dried beef, suet, raisins, and sugar.

BUFFALO PATHFINDERS

Many of America's historic highways were originally buffalo trails. The beasts knew and followed the best routes through mountain passes and across the continent. Great steel and concrete highways now proceed along the trails once trodden by bison.

BISON COUNTRY

The typical bison is primarily a plains animal—it favors open, flat grass country bare of trees yet well supplied with water. The center of abundance of the American bison was the great plains of the Mississippi River valley, where the land was unforested and well watered. Here, and here only, was the bison found in herds of millions.

Formerly the bison roamed over most of the United States with the exception of the arid deserts and the Pacific coast region. In the West, the range extended north to Great Slave Lake in Canada; southward these beasts reached into northeastern Mexico. Continually on the move, the herds ran no danger of overgrazing, despite their excessive numbers.

PORTRAIT OF A BEHEMOTH

A great, powerful beast with a massive head and neck and humped shoulders, the bison is, however, surprisingly narrow, especially in the hindquarters. A thick mantle of long, shaggy hair envelops the head, neck, and forelimbs but stops abruptly at the shoulders. A long black beard hangs from the chin of adult males, and the rest of the body is covered with comparatively short, close hair. The short, stout horns curve out and upward, while the tail, though short, carries a tassel of long hair.

Average full-grown bulls measure over five feet high at the shoulder and weigh around sixteen hundred pounds. The record weight is three thousand pounds. Cows are considerably smaller, weighing from seven hundred to nine hundred pounds. The general color of the animal's coat is a rich dark brown, becoming almost black on the head and shoulders. With the coming of spring and the molting season, the black cape fades to a pale yellowish brown.

THE RUTTING SEASON

At the approach of the rutting season in June and July, the bulls fight for supremacy of the herd. Battles between two evenly matched bulls may last two days and a night in succession. The animals often struggle until both are exhausted, and sink to their knees; then they take up the fight again after a brief rest. When the issue has been settled, the victor is comparatively quiet, presumably too busy with his females to remember his recent quarrelsome feelings; as for the vanquished bull, he bellows incessantly, day and night. Bulls rarely make an unprovoked attack on man, even during the rutting season.

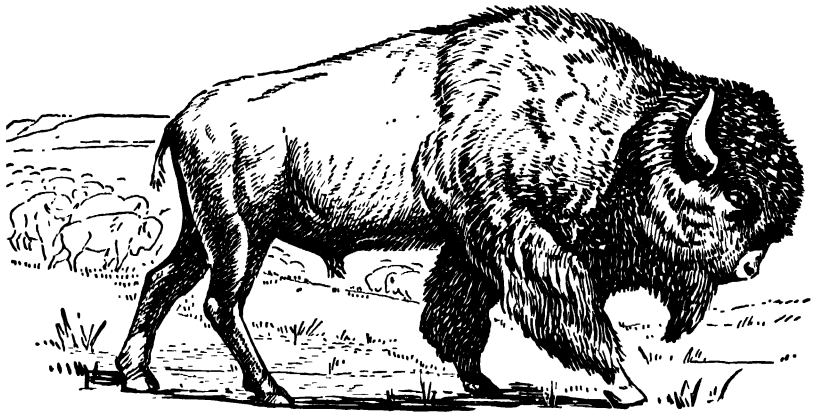
The calves may come any time between April and June, but most of them are born in May, nine and one-half months after the adults have mated. Usually there is only one calf, occasionally twins. The newborn calf's coat is bright tawny, almost yellow, with a dark reddish band down the middle of the back. By the time the mother has licked her offspring from head to foot, the calf is ready to stand on its shaky legs for its first meal.

Most animals will turn their back to a storm—not so the bison.

Better clothed in front than behind, it will meet a blizzard of driving snow and bitter cold with its head directed into the wind.

BISON OF MOUNTAIN AND WOODS

Among the bison that are now extinct in the United States, one mountain-dwelling form lived in Colorado, while another type frequented the forests and hills of Maryland, Pennsylvania, and Virginia.



THE BISON, STALWART WILD OX OF FRONTIER AMERICA

The bison or plains buffalo once roamed the United States and Canada in hordes four million strong; their flesh and hides provided the necessities of life for the pioneers. Bison trails were so excellent, the highways of today were built upon them. This strong and dignified animal, with its massive face and black beard, now remains largely as a symbol of a courageous chapter in America's past.

The Wood Bison, a third variety, is larger and taller than the plains bison. The last of the truly wild bison, it still exists in the remote Slave River region of northern Alberta in Canada. The shoulder height of grown bulls may exceed six feet. These animals are marked by a broad brown band extending down the middle of the back.

VIGIL IN THE SNOW

That the behavior of wild animals is often unpredictable is well illustrated by this striking experience which the author had when he was in the Slave River district of northern Alberta, collecting a group

of wood bison for the Canadian National Museum. The expedition's efforts were crowned with success—the writer shot two bison. Then, for a while, he was all alone in the wilderness; his companions went off to make contact with the hunting party's airplane. One of the men had borrowed the author's rifle, leaving him without any weapon but his knife, which he needed in order to skin his bison.

Soon it began to snow. The author paused to rest from the tiresome job of skinning. Glancing around, he saw a big bull bison standing motionless not fifty yards away, and staring straight at him. Next time the writer looked up, the bison was still there, snow drifting in its face. From another direction there appeared two bears, then a third, standing up on their hind legs and watching intently . . . if not hungrily.

By dark, one skin was off. The author thought of pulling it over himself to keep warm, but it was not improbable that the animal spectators might take him for a dead buffalo, and an excellent candidate for their next meal; it seemed better to stay cold and keep the respect they owed him as a human being. He heard a piercing wolf call that sent cold shivers down his back. Then another and another wolf answered. Finally all was silent in the pitch-black night and he fell asleep. About midnight, the writer woke up, fancying that he could hear some creature breathing not more than ten paces away. A wolf was outlined against the snow. Soon it vanished into the night. Next morning, when the sun rose, all the visitors were gone.

CORTEZ AND THE BISON

Most books tell us that the Spanish explorer Hernando Cortez was the first European to view the bison. In 1519, so goes the story, Cortez stood in the courtyard of Montezuma's palace after having fought his way to the Aztec capital, now Mexico City. There he saw a strange creature with a humped back and shaggy coat which he described as a "rare composite of several divers animals."

The source of this story is Solis' *Historia de la Conquista de Méjico*. However, it seems that Solis never was in Mexico. He may have assumed that Cortez had seen one in the Aztec emperor's zoo, and proceeded to invent an account of such a visit.

On the other hand, Bernal Díaz del Castillo, who was a member

of the Cortez expedition, described Montezuma's zoo in detail. His book mentions tigers, lions (not the African varieties, of course), and foxes, as well as a rattlesnake and a great variety of colorful birds; but he makes no reference to anything like a bison. Cortez's fame will thus have to rest on his conquests exclusively—the bison will henceforth have no part in it.

WHO WAS "BUFFALO BILL"?

That famous buffalo hunter, frontiersman, and scout, William F. Cody, has gone down in American history as "Buffalo Bill." He was, however, not the only one to bear that title. There were many "Buffalo Bills," each claiming sole right to that name.

William Mathewson was perhaps the first to be named "Buffalo" and acquired the title during the great drought of 1860. A quiet, unassuming fellow, he earned the gratitude of the starving people of western Kansas by feeding them with large quantities of buffalo meat.

Cody was of course the traditional Buffalo Bill, with his inseparable buffalo horse Brigham and his equally inseparable buffalo gun, by name "Lucretia Borgia." Cody acquired his title in 1867 when the Kansas Pacific Railway pushed into buffalo country. The railroad company hired Cody to kill buffalo because the beasts were a nuisance in the vicinity of a railway route and because they attracted Indians, who were becoming very troublesome at that time. By slaughtering buffalo, the white man deprived the Plains Indians of their chief source of food. It was the railroad hands that gave Cody the title of "Buffalo Bill."

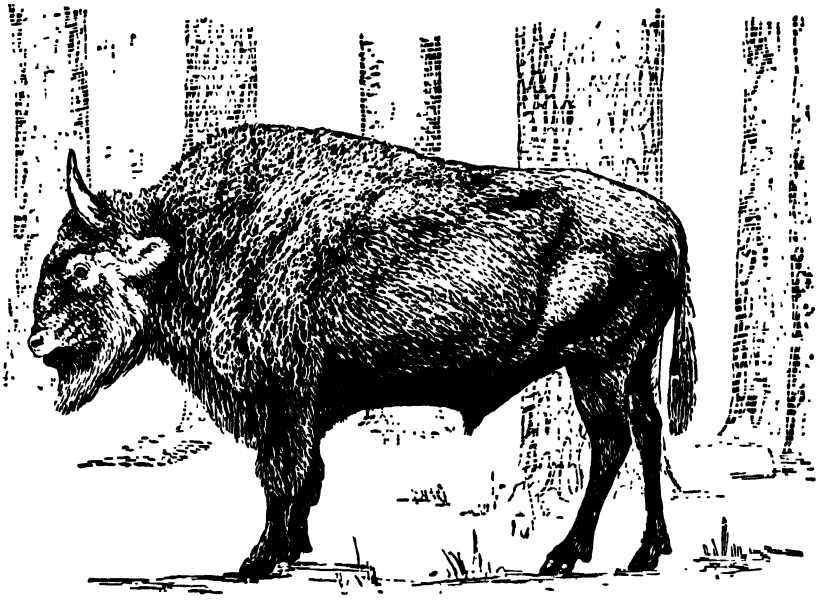
Colonel Charles J. Jones, better known as "Buffalo" Jones, was famous for his lassoing ability (earlier we saw how he used it in Africa), and was largely responsible for collecting the buffalo herd in Yellowstone National Park today. He was appointed park warden in 1902. Jones trained a pair of bison to haul a cart and later used them to plow the land.

WISENTS—EUROPE'S BIGGEST MAMMALS

The Wisent, or European Bison, *Bison bonasus,* once at home in many of the forests of Asia and Europe, including England, is now

extinct in the wild state; the few remaining animals are in the Duke of Bedford's park at Woburn, England.

A typical bison in appearance, the wisent has humped shoulders covered with a close curly mane. The rest of the body is covered with short, thick, woolly brown hair. The horns are short, rounded, and curled slightly upward.



EUROPE'S NEARLY EXTINCT BISON

The wisent or European bison, like its American kin, has powerful mane-covered shoulders rising to a hump, a large neck and head, and hindparts that look slender by comparison with the rest of its body. Two World Wars have wiped out this animal from those parts of eastern Europe where it once lived.

Larger than its American cousin, the European bison (or aurochs, as it is often erroneously known) has a mane which is shorter and less shaggy than the New World bison's. The bull of the European bison is the largest of the native European mammals. Weighing up to two thousand pounds, it stands over six feet at the shoulder, and measures over ten feet from the nose to the root of the tail.

Under the protection of the Russian czars, the wisent existed in fair numbers in the forests of Bielowitza, Lithuania, and the Kouban

district in the Caucasus until the beginning of World War I. However, what animals remained in these places were exterminated in World War II.

Antelopes—Renowned for Grace and Speed

THE ANTELOPES are famous for their speed, grace, and good looks. Generally creatures of light and slender build, they nevertheless come in many shapes and sizes. In this big group of animals we find, for example, the Royal Antelope, which stands only ten inches at the shoulder—and, by way of startling contrast, the Giant Eland, an oxlike animal which weighs twelve hundred pounds.

Among antelopes' horns there is a great deal of difference, too. As a rule, an antelope's horns rise from the head and then sweep backward. Yet some horns are straight, some spiral shaped, others lyre shaped; still others have fantastic curves. There are even antelopes with four horns instead of two. Among some kinds of antelope, both sexes have horns; among others, only the males are horned. Even the length of the horns shows startling variations—on the smaller antelopes we find horns that are mere stubs, while the larger animals may have horns forty inches long.

Some antelopes gather in herds of anywhere up to ten thousand; others are shy, elusive, solitary creatures. Where do these cud-chewers live? In all sorts of places—marshes and swamps, deserts, open plains, dense forest, and mountains. Africa is the home of most antelopes; there are also some that are native to Asia. We do not find these animals outside the Old World. Their closest relative in America is the mountain goat.

One thing in general may be safely said about the antelopes: they are the most graceful and most decorative of all the members of the family Bovidae.

THE ANTELOPE IN ANCIENT TIMES

The hartebeest was one of the few African antelopes known to ancient writers. Herodotus includes it among the beasts of Libya. Aristotle, Aeschylus, and Pliny also mentioned the hartebeest.

The name "antelope" seems to be of fabulous origin. According to one authority, it was originally derived from a Coptic word signifying "unicorn." Ancient naturalists used the term "antelope" to designate an imaginary animal that lived on the banks of the Euphrates and cut down trees by using its horns as a saw. In fact, Linnaeus, many centuries later, placed the antelope among the fabulous animals, in the first edition of his great work on natural history. In a later edition he ignored the antelope altogether.

Few people realize that, strictly speaking, the blackbuck of India is the only true antelope in the world. The word "antelope," as a scientific name, is applied only to the blackbuck. As far as the early writers were concerned, it was *the antelope*—there were no others.

ANTELOPES WITH SPIRAL HORNS

GREATER KUDUS—FINEST OF THEIR TRIBE

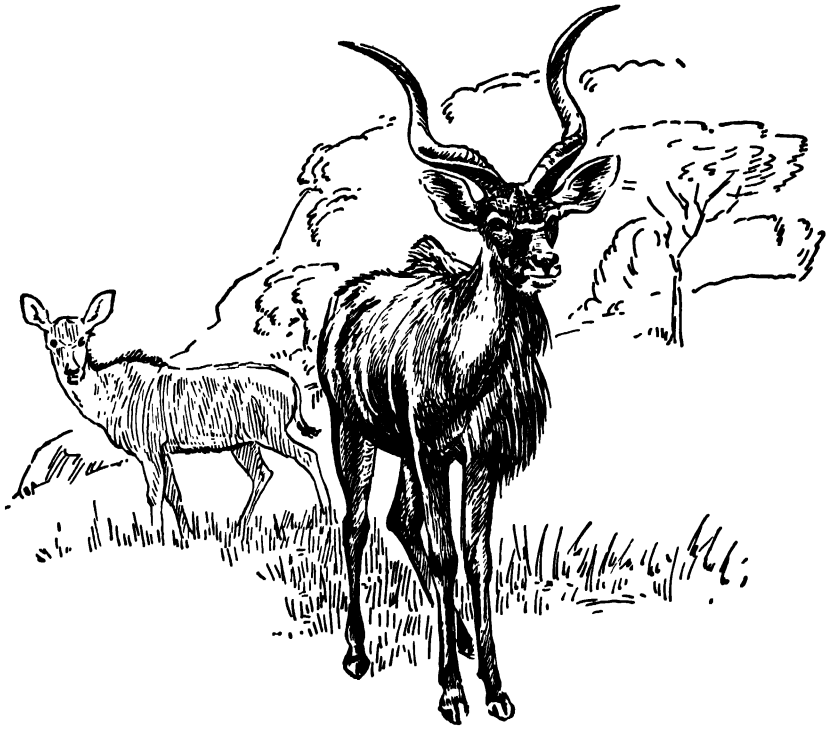
The "Antelope King." The Greater Kudu, *Strepsiceros strepsiceros*, a large creature with lengthy corkscrew horns, is one of the stateliest-looking antelopes in all of Africa. Sometimes called "the antelope king," it has been described as the finest of all its tribe—and not without reason.

Shy and Elusive, Yet Courageous. In their dances of triumph to celebrate the killing of a lion, the natives often give periodic blasts from their traditional kudu horn trumpets. This is about as near to a wild greater kudu as the average hunter or traveler will ever get. Outside of parks and game reserves, the kudu is extremely timid and elusive.

If one is to see the greater kudu at all, it will be in the bush or in scrub-covered rocky hills, where the animal can climb like a goat and keep a sharp watch for approaching danger. It is helped by the camouflage of its striped gray coat, which is difficult to make out in the bush.

When the kudu is hunted, and hard pressed by dogs, it will take to

the rivers, swimming steadily downstream. Usually it outdistances its pursuers in the water. At times, it proves to be a most courageous animal—when cornered or wounded, it will attempt to defend itself against both man and dogs. Hunters say that an experienced old bull, once it knows it is being tracked, will try to startle a less mature kudu out of the bush, so that the attention of the pursuers will be diverted. How true this is, only the old bull can definitely answer.



IT APPEARS TO BE FOREVER IN FLIGHT

This African antelope, rarely glimpsed by man, is known as the greater kudu. An adept climber, it lives among rocky hills, where it can maintain a lookout for danger. The male has horns like giant corkscrews, but the cow is hornless. During the rutting season, when males fight for a mate, their horns sometimes become fatally interlocked.

Corkscrew Horns. The glory of the kudu bull is its magnificent horns. They may reach a length of sixty inches or more, and are fashioned in the form of long, wide, open spirals of two and one-half turns; cows are hornless.

This proud, erect animal stands almost five feet at the shoulder, and

bulls weigh between five hundred and seven hundred pounds. The coat is grayish brown in color with vertical white stripes along the sides of the body. The face is bedecked with white markings on the nose, cheeks, and around the eyes. The kudu's ears are large, the tail moderately long and tufted; there is a fringe of long hair on the throat of both male and female.

The Rutting Season. Except during the breeding season, when small herds or family groups are the rule, the sexes live apart, and the males keep bachelor quarters. Bulls fight during the rut, and occasionally this results in inseparably locked antlers. The deep, hoarse barks or "bugles" of the kudus are the loudest sounds made by any antelope.

Cows usually have one calf at a time, seven or eight months after mating. Kudus have survived in captivity for over eleven years.

The range of the greater kudu and its local relatives extends from Ethiopia to South Africa. In the bush and rocky hill country which it loves, its favorite food is leaves, grasses, and wild fruits.

LESSER KUDUS—REMARKABLE JUMPERS

The Lesser Kudu, *Strepsiceros imberbis,* is a remarkable jumper. It can cover over thirty feet in a single leap over bushes; it almost seems to be flying as it hurtles gracefully through the air, six feet above the ground.

Similar to the greater kudu in appearance, this lesser relative is much smaller; the colors are brighter, the horns less divergent, there is no fringe on the throat. Vertical stripes adorn the lesser kudu's body, while a white arrow bridges the nose below the eyes. The shoulder height is usually under forty inches.

A very timid and inoffensive creature, the lesser kudu is found in the dry, bush-covered plains from Somaliland to Kenya in northeastern Africa.

SITATUNGAS—BUCKS OF THE MARSHES

The Sitatunga, or Marsh Buck, *Limnotragus spekii,* comes as close to being a water animal as any antelope. Its home is the big swamps and watercourses of central and eastern Africa. In the sitatunga's damp haunts, the natives usually pursue the wary beast in dugout

canoes; in the dry season they are able to fire the bush and drive the sitatunga out into the open.

The Sitatunga in the Water. The sitatunga can swim, dive, and travel a considerable distance under water. When frightened, it frequently takes refuge in deep water, often lying submerged with only the nostrils and eyes above the surface. Its feet are especially adapted for a life near water. The halves of the long, slender hoofs spread widely when the animal walks or runs, thus providing ample support on a tangled mass of weeds. On the soft mud it leaves a V-shaped spoor.

The sitatunga never ventures out into the open to feed except at night; when disturbed, it makes for the nearest marsh or swamp. On hard ground it is clumsy, even awkward, and can be overtaken by a fast runner.

Grown male sitatungas stand a bit less than four feet at the shoulder. Their hair is brown, with stripes. Males have spiral horns twenty-eight inches long measured in a straight line from base to tip, and thirty-five inches following the spiral curve. Females are hornless. They and the young are of a bright chestnut color, with white stripings and spottings, as a rule.

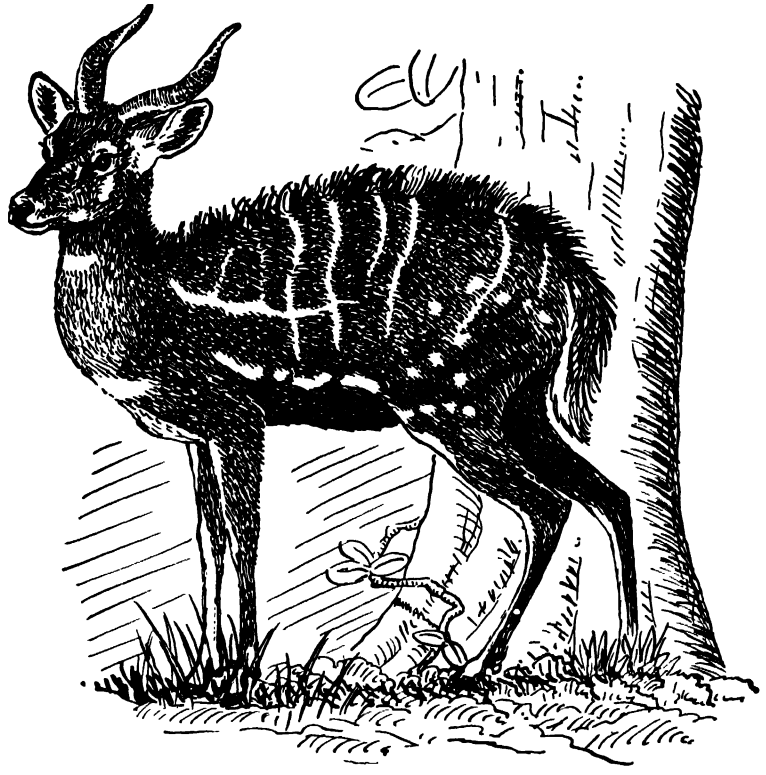
BUSHBUCKS—DANGEROUS WHEN WOUNDED

The Bushbuck, or Harnessed Antelope, *Tragelaphus scriptus,* is a lover of solitude; it lives alone, or at most in pairs during the breeding season. Active only by night, it lies up by day in dense brush. Both sexes utter a hoarse bark, but the male has a louder and harsher note than the female.

Timid in the Wild, Aggressive in Captivity. The bushbuck is one of the wariest of African antelopes and frequently takes to water. It generally trusts for safety to its wariness and the concealment offered by the bush. The bushbuck is rather noisy, however, and utters its deep bark when it hears unusual sounds or smells a man or a leopard. When wounded, the animal often proves to be quite dangerous. There are instances of rams killing a man, a leopard, and a wild dog. In captivity the bushbuck is very aggressive; the rams may kill or severely injure the ewes.

The males of the subspecies of bushbuck differ greatly in color, varying from a nearly black animal to a bright chestnut. All forms have

white stripes running down each side, two slantwise stripes, a dozen or so white spots on the hind limbs, and a white band across the chest. The young and the females are always a bright chestnut with characteristic white stripings. A small antelope, the bushbuck seldom stands more than three feet at the shoulder; its simple spiral horns rarely exceed eighteen inches in length. There is a fringe of stiff, erect hairs along the back.



A STUDY IN SOLITUDE

Deep in the forests of Southern Africa, the bushbuck or harnessed antelope leads a shy and hermit-like existence. Only at mating time is this lonely creature seen in pairs. On its beautiful russet-colored coat are vivid stripes and spots of pure white.

The bushbuck is found in many parts of Africa south of the Sahara, and there are well over twenty named geographical forms. Primarily a forest animal, it also occurs in the thorn-bush country and may feed in the open-range country bordering the forestlands. Occasionally it invades and damages gardens and farmlands.

Bushbucks breed at all seasons of the year and the young are born from six to seven and one-half months after mating time.

THE NYALA—HANDSOME ANTELOPE OF ZULULAND

The Nyala, *Tragelaphus angasii,* is a handsome, short-haired antelope with a distinct color pattern for each sex. "Nyala" or "Myala" is the native Zulu name for this most beautiful antelope.

A relative of the bushbuck, the nyala frequents the hot, low country and more or less open bush near rivers and lakes in Zululand and the neighboring country.

Occasionally the nyala is solitary, but more often it is seen in small parties of females and young, or equal numbers of males and females. Often the males spar together with their horns; but once the rutting season arrives, they battle in real earnest.

Males are slate gray and stand about forty-two inches at the shoulder. They have spiral horns that measure twenty-four inches in a straight line and thirty inches with the curves. The females are hornless and reddish chestnut in color. Both sexes are beautifully marked with numerous vertical white stripes on the body and a white spinal fringe extending from the shoulders to the base of the tail.

How the Nyala Is Trapped. The occasions on which you can get a fleeting glimpse of this handsome beast are apt to be few and far between. When surprised, it is off like a flash, leaping over the bushes, its horns laid back and nose outstretched, to disappear in the dark recesses of the bush.

Natives trap the nyala by enclosing its much-frequented haunts and leaving little gaps in the fence. In each trap there is a noose of stout cord made of tough fiber. One end of the cord is fastened to a sapling which is bent over the gap and held in place by a trigger. As the nyala steps through the gap, it releases the spring sapling, one of the animal's legs, caught in the noose, is hoisted in the air and so the nyala can neither struggle nor try to escape.

The Mountain Nyala, largest of the bushbuck types, occurs in the highlands of southern Ethiopia. It stands four and one-half feet at the shoulder.

ELANDS—BIGGEST OF ANTELOPES

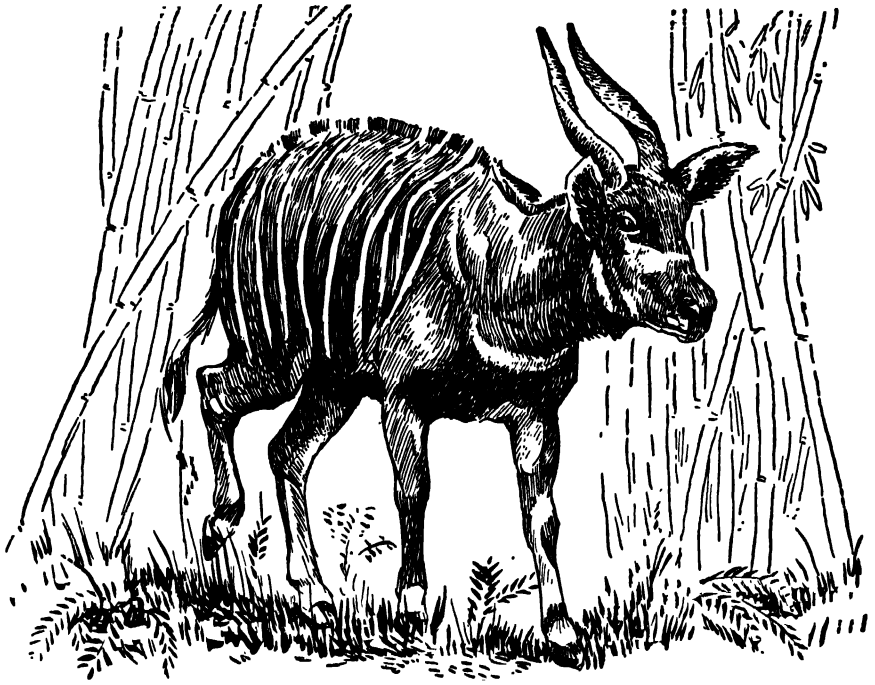
Strictly an African animal, the Eland, *Taurotragus,* got its name from the Dutch settlers. *Eland* is the Dutch word for "elk," an appropriate name, the Dutch felt, for the largest species of antelope they had encountered. Actually the eland is quite different from either the elk, or other antelopes. A heavy fold of skin—a dewlap—hangs from the bull's neck, and this enormous creature is rather oxlike in appearance.

A Great Traveler. For all its large size, the eland is swift and agile. It will often spring into the air, leaping high over the back of one of its fellows.



THE ANTELOPE HEAVYWEIGHT

An outsized antelope, the giant eland tips the scales at twelve hundred pounds. Despite its bulk, the eland has the speed, grace, and agility typical of antelopes. It can leap high into the air—even over the back of another eland—with acrobatic ease. Distinctive of the eland is a loose flap of skin hanging from its neck.



THE UNAPPROACHABLE ONE

The bongo will seldom appear in the open; its home is hidden deep in the thick bamboo forests of West Africa. Here, surrounded by a protective screen of trees and dense vegetation, the bongo listens for the faintest sounds of the hunter's movements. Almost invariably, its sensitive ears hear the pursuer in time for the animal to disappear completely into a thicket before it can be shot.

NILGAIS—BLUE BULLS OF INDIA

The Nilgai, or Blue Bull, *Boselaphus tragocamelus,* is common in central India, where it is regarded with reverence because of its color. The largest Asiatic antelope, it stands about four and one-half feet at the shoulder. In a general way its form is somewhat horselike, but the neck is deep and compressed, while the tail reaches the hocks. The horns are curved spikes—they are rather short (eight to nine inches) and triangular at the base. It is easy to tell the sexes apart. The bull is iron or blue gray in color, with a tufted throat, while the cow is hornless and fawn colored. Both sexes have a mane of stiff hairs.

In some localities the nilgai becomes quite tame. It wanders across

cultivated lands and is troublesome to crops. However, as the Hindus regard it as a sacred cow, most do not molest it. Sportsmen rarely care to shoot the nilgai; its meat is inferior to that of most Indian wild game.

When alarmed, the nilgai travels at a fast gallop. A bull can only be overtaken by a good horse, while a cow, it is said, cannot be run down by a single rider.

The nilgai can be tamed, but males are often savage in captivity. Some of these animals have been harnessed and taught to draw light carriages; one even allowed itself to be used to carry light loads and human riders.

The nilgai's name, of Persian origin, means "blue ox." We find the big Indian antelope on level or undulating ground, usually where thin brush and scattered trees alternate with open, grassy plains. It is rarely encountered in the thick forest, though it browses on shrubs and low trees in addition to grazing on low herbage.

Each year the cow nilgai gives birth to one young—sometimes a pair—eight to nine months after mating. Old bulls are often solitary, but parties of fifteen or twenty animals are not unusual.

ANTELOPES WITH FOUR HORNS

The Four-horned Antelope, *Tetracerus quadricornis,* differs as much from other Indian antelopes in habits as in appearance. It is extremely shy and solitary; more than two individuals are rarely seen together.

This antelope dwells along the base of the Himalayas from Punjab to Nepal and in other parts of the Indian Peninsula. Here it frequents scattered forest country and thin bush, and undulating or hilly ground in particular. It moves with a peculiar jerky motion.

Whereas the doe is hornless, the buck, unlike other antelopes, has two pairs of horns; the additional pair, located on the forehead, rarely exceed two inches in length and often exist only as short knobs. The normal or posterior horns are simple spikes not more than four or five inches long. This antelope's color is pale brown; an average buck stands two feet at the shoulder and weighs forty-three pounds.

The young—one or two in a litter—are born in January or February, about six months after mating time.

DUIKERS–THEY "DIVE" INTO THE BUSH

Duikers, or duikerboks, are small African antelopes that frequent forest and bush country. They average about two feet in shoulder height. Duiker means "diver," a name given these small antelopes because of the way they plunge into the underbrush and thickets.

There are at least twenty kinds of duikers; these have been divided into about eighty named geographical forms. In almost all, both sexes have short spiked horns. In general we place these creatures in three groups: bush duikers, blue duikers, and forest duikers. The first group is the commonest.

The Duikerbok, Common Duiker, or Bush Duiker, *Sylvicapra grimmia,* is plentiful over all of Africa, from the Cape of Good Hope to Ethiopia. The color of the coat varies from grayish brown to bright yellow. The males have short horns; the females are usually, though not always, hornless, unlike other duikers.

——DUIKERS IN THE WILD. The duikerbok lives in thick brush country, where it remains concealed until forced to leave; then it gallops off, more like a rabbit than an antelope. Particularly noticeable at such times is the white "flash" of its tail as it dodges from one bush to another or to the nearest patch of cover.

A male and a female usually associate together. When one darts off, its mate is usually concealed at no great distance. However, the two animals usually take off in different directions.

Steinhart, one of the foremost authorities on African game, connects the guinea fowl with the bush duiker and records seeing them at play together. He believes that the sharp-sighted guinea fowl may act as a sentinel. When wounded, caught by one of the big cats or a dog, a duiker will utter a wild scream like a hare. At all other times it is quiet. A young lamb will bleat incessantly when separated from its mother.

Duikers are easily tamed, and will breed in captivity. Some have lived eight or nine years in zoos.

While both sexes are alike in color, the female may be bigger than the male. The average shoulder height is about twenty inches, while thirty pounds is the maximum weight. The young differ from their parents only in shade of coloration. Several all-white duikers have been recorded.

Though twins are not frequent, they seem to occur more often than among some other African antelopes. The adults mate in October, and about seven months later, generally in May, one or two young are born.

The Zebra Duiker. The Zebra duiker is one of the most strikingly colored of the many species that are included in this group of small antelopes. A beautiful little creature, it has an orange-red coat marked with tiger-like stripes of black on the back. Inhabiting the dense forest of Sierra Leone, the zebra duiker is known there as the "mountain deer."

WATERBUCKS—AT HOME IN THE WATER

The waterbuck goes about in herds of from five or six to about twenty individuals—though some groups may take in as many as a hundred. One bull usually has a harem of ten or twelve cows.

A grass feeder, the waterbuck usually occurs on grass flats near water or swampy plains. Where there is waterbuck, you may be sure that water is no more than five or six miles away.

Though it lives on solid ground, the waterbuck, when hunted, will take readily to the water; it is a good swimmer. Followed by dogs, it will turn on them if it possibly can in deep water when it has the advantage. Still, the waterbuck is not a water antelope in the strict sense that the sitatunga is.

The author found waterbuck the least wary of African big game and among the most common. Hunters rarely shoot this animal, probably because its flesh is stringy, coarse, and unpalatable—at least to the white man.

The Defassa, or Sing-sing Waterbuck, *Kobus defassa,* is a large antelope about fifty inches at the shoulder, with coarse, rather long shaggy hair. Males have lengthy, heavily ringed horns, lightly curving backward, upward, and slightly forward at the tip; females are hornless. The defassa waterbuck dwells in western and north-central Africa. Grayish brown in color, it has a large white patch below the tail.

The Common Waterbuck, *Kobus ellipsiprymnus,* is about the size of the defassa. Large bulls range between four hundred and 550 pounds, bearing horns that measure anywhere up to thirty-nine

inches, though the average is considerably less. Darker in color than the defassa, the common waterbuck is distinguished by a conspicuous white line encircling the rump.

Male waterbucks fight fierce battles for the possession of the females. The calves, usually twins, are born eight months after the adults mate. Reddish at first, the young soon change to the mixed gray and black of the grownups.

The waterbuck has a wide range extending from South Africa to British East Africa and Somaliland. Often it is seen together with wildebeests and zebras.

KOBS, LECHWES, AND REEDBUCKS—WATER-LOVING ANTELOPES

KOBS LIKE COMPANY

Sociable creatures, the kobs usually travel in small parties of seven or eight individuals. Every now and then the small groups join together to form a large herd of fifty animals or more, with both sexes represented.

In its habits the kob is somewhere in between the bushbuck and the lechwe. Always found very close to water, it favors solid ground on which to graze. We never find the kob on the treeless, flooded grass plains where the lechwe is at home.

Buffon's Kob, or the Western Kob, *Adenota kob,* has somewhat lyre-shaped, heavily ringed horns. The general coat color ranges from rich tawny in the typical form to the brownish black of the white-eared kob of the upper Nile. The young, as well as the females, are reddish brown.

The full-grown adult male measures about thirty-five inches at the shoulder. Kobs are concentrated in Equatorial Africa, from Guinea to Uganda and the swamplands of the Nile.

The Puku, *Adenota vardonii,* is similar to the kob, but has much shorter and heavier horns. It is a reddish-yellow animal, with rather long, wavy hair. The shoulder height is about forty inches, the average weight 190 pounds. The puku frequents the swamps and plains of northern Rhodesia, Nyasaland, and the Zambesi River valley.

LECHWES—PREYED UPON BY CROCODILES

The Lechwe is much more at home in the water than the bushbuck or the kob. Nearly always found in shallow water, the lechwe spends most of its time feeding knee-deep in a swamp. When resting, it lies up at the edge of the water—or even in shallow water.

A strong swimmer, the lechwe, when hard pressed, will make for thick reed beds, where it is hard to find. Crocodiles occasionally get a lechwe; on one occasion, natives once produced the hide of a lechwe that had been hauled out of the jaws of a crocodile. The natives kill large numbers of lechwes for the flesh, which is quite tasty—far superior to the waterbuck's. The natives hunt the lechwes in canoes; they drive the animals into deep water, where they spear them.

Although it is the most water-loving of all African antelope with the exception of the sitatunga, the lechwe also travels on land in herds of from ten to fifty or more. Disturbed, this antelope moves with a lumbering gait. When the lechwe gallops, its head is lowered and outstretched, with the horns lying back on the shoulders. It is alert and wary; keeping well out in the open when feeding, it will dash for cover to hide at the slightest hint of danger. One of the noisiest of the antelope, the lechwe, once it is alerted, utters a continuous series of croaking grunts.

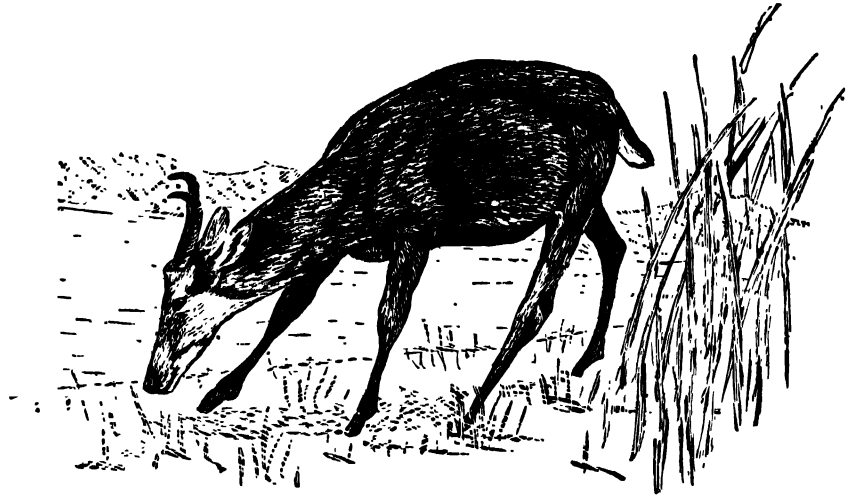
The Red Lechwe, *Onotragus leche,* has rather long horns. They exceed twice the length of the head and show a slight double curvature. The red lechwe stands about forty inches at the shoulder, and has long, coarse, black hair. It is common on the plains and in the swamps of northern Rhodesia, Zambesi, and Nyasaland.

The Nile lechwe is a handsome variety which we find in the swamps along the White Nile. The long, slender, double-curved horns are ridged nearly to the tip, and the average shoulder height is about thirty-eight inches. Old bucks are dark brown—almost black—in color, with a white patch on the shoulders. Females and young are chestnut.

REEDBUCKS—OUT OF THE WATER FOR SAFETY

Strictly creatures of dense cover, the reedbucks rarely show themselves in the open. Nor are they sociable; we are likely to see only one ani-

mal alone, or two together—a doe and her fawn, rarely a male and female. These gentle creatures are seldom found more than three or four miles from water. Feeding largely at night or early morning, they haunt tall grass swamps or reed beds.



ANTELOPE OF THE WATERSIDES

The reedbuck is found near many of the lakes and rivers of Africa. There are nine different varieties of this water-loving animal, each varying slightly in its size and the place we find it. Some of these animals prefer high, grassy hillsides, while others favor low swamplands. The bohor reedbuck, above, is typically yellowish-red in color, with a short, bushy tail that bobs like a rabbit's when the antelope runs.

One interesting point of difference between the reedbuck and many other antelopes is this: while the reedbuck is always found in the neighborhood of water, it does not take refuge in it when pursued. Instead, it flees into the dry bush.

Alarmed, the reedbuck moves off with a rocking gait, kicking its heels in the air and flashing its tail, white on the under side, like a rabbit. Whenever this antelope is suddenly startled, it utters a sharp, distinctive whistle. In places where many reedbucks are abroad, you can hear this whistle periodically throughout the night.

The Bohor Reedbuck, *Redunca redunca,* found throughout most of Africa, frequents plains, swamps, and mountain country but avoids heavy forests. Slenderer than the kob, it has also a shorter and bush-

ier tail. The black, ridged horns, twelve to sixteen inches long, spread upward and outward with a forward curve at the tip.

The average height of the bohor at the shoulder is about thirty inches, and the general color is yellowish red; it is among the largest of the nine different kinds of reedbucks.

A Mountain Antelope. The Gray or Vaal Rhebok, *Pelea capreolus,* is a close relative of the reedbuck. The vaal never enters the forest; instead, it lives in mountain passes and rocky glens in small family groups—an old male with five or six females and their young. Spending the day on the hilltops and descending to the lower plains to feed and drink, the vaal makes its way back soon after sunrise. This creature is possessed of boundless energy; it would be hopeless to try to overtake a vaal rhebok from below.

Projecting straight up from the head of the vaal are short, slender horns. Its ears are long and narrow, the tail moderately long and bushy. The somewhat woolly hair is pale gray, while the head and limbs are fawn colored. Females are about twenty-eight inches high at the shoulder; males are two or three inches taller.

The vaal rhebok frequents the open hilly regions of South Africa.

SABLE AND ROAN ANTELOPES—STRONG AND STATELY CREATURES

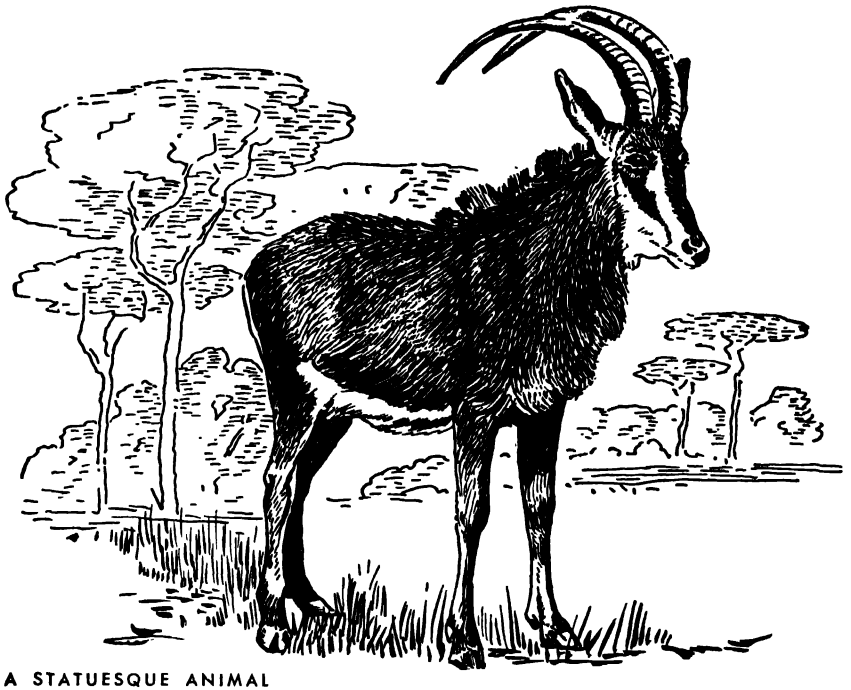
The Sable Antelope, *Hippotragus niger,* is the most stately, if not the most magnificent, of all the antelopes. Its only possible rival, said Theodore Roosevelt, is the greater kudu.

Unlike the deer and most other antelopes, the sable arches its neck when running—like the champion at the horse show. Though it can travel at a good clip if need be, it is not so fast as the wildebeest. Largely, though not entirely, a grass-eater, it favors thinly forested country where there is ample cover interspersed with open sunlit glades. Alarmed, it utters a series of snorts much like those of a horse. If wounded and cornered, the sable will fight savagely for its life.

——Superb Horns. Both male and female sable antelopes are well armed—they have superb sickle-shaped horns sweeping backward from the face in an arc that may reach a length of sixty-four inches. The horns have extremely sharp points, and this courageous animal knows how to make effective use of them in defending itself from

attack. About four and one-half feet at the shoulder, the sable weighs 450 pounds. It has large ears and an erect mane.

Females and young are reddish brown with considerable white about the muzzle and below the eyes. Becoming darker with maturity, the males are almost black by the time they grow up.



A STATUESQUE ANIMAL

Handsome and dignified, the sable antelope runs with its head drawn back, like a fine, spirited horse. It likes the company of the herd, in which it travels with from ten to eighty of its fellows. Notice the splendid sickle-shaped horns—they may extend to an impressive length of sixty-four inches.

The range of the sable antelope includes the Transvaal, Rhodesia, and the coast districts of East Africa, where it travels in herds of anywhere from ten to eighty—though groups of more than twenty are rare. Even in large herds there is only one adult bull. The old ones and the young competing males are not permitted to join the herd; instead, they associate in small bachelor groups.

The Roan Antelope, *Hippotragus equinus,* like the sable, can travel at a fast pace. Its gallop is rather heavy but strong and brisk, much

like that of a horse. When it travels on hard ground, you can hear its hoofbeats for quite a distance.

Slightly larger than its cousin the sable antelope, the roan has considerably smaller horns—usually less than thirty inches long—and its ears are longer. The roan antelope stands almost five feet at the shoulder, weighing approximately 625 pounds. The male has a grizzled roan coat, very different from that of the bull sable antelope. The animal is a doughty fighter, as many a pack of wild dogs have discovered, to their sorrow.

The roan favors rather open regions, usually upland, rolling country, not thickly wooded. In East Africa it goes up to an elevation of sixty-five hundred feet, but it does not care for higher altitudes. Primarily a grass-feeder, the roan will travel long distances away from water; when water is available, the animal drinks regularly about daybreak.

There are seven known types of roan antelope, and their combined range extends throughout the plains of Africa north of the Orange River.

ANTELOPES WITH STRAIGHT HORNS

GEMSBOKS—THEIR HORNS ARE DANGEROUS WEAPONS

The Gemsbok, *Oryx gazella,* may not be the fleetest antelope on the African veld, but it requires an exceptionally fast horse to overtake one. When hard pressed or attacked, the gemsbok will boldly defend itself. Pursued by dogs, either domestic or wild, it will quickly turn on them.

The gemsbok has four-foot-long rapier-like horns that extend backward and upward from the head. Both sexes normally have horns, but those of females are longer. A gemsbok is fast as lightning with these sharp weapons. Natives report instances of lions found transfixed on the horns of the gemsbok.

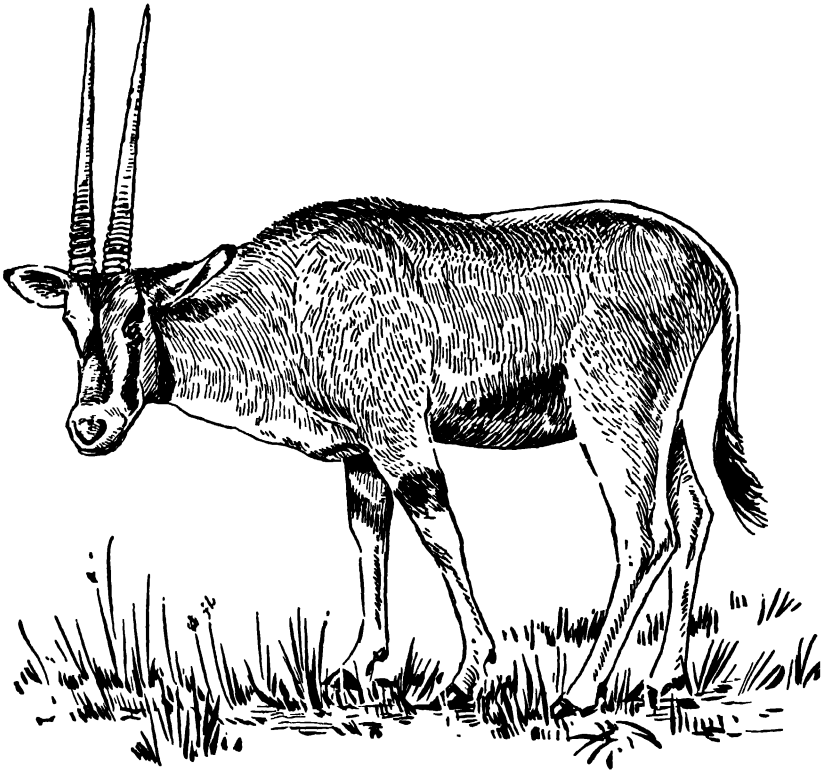
Graceful Creatures. Gemsboks are sociable animals, frequenting open country. A herd of gemsboks trotting in single file is one of the most spectacular sights of Africa. They stride along in soldierly fashion, their long, slender horns gleaming like bared sabers in the sunlight as these animals whirl about in unison before coming to a stand.

The gemsboks cover the plains with an easy, swinging trot or gal-

lop and seem to skim along with an effortless glide. When they walk, their heads nod with each step, as in the case of a horse. The author has watched the graceful creatures gallop away across the veld. Singularly inconspicuous even in wide open spaces, they seem to disappear in the dancing mirages.

A gemsbok resembles a thoroughbred in its carriage and posture. Neat and compact in build, it has a level back and a short, horselike neck. The general color is grayish brown with a black stripe extending along the lower sides of the body.

Gemsbok Babies. The young gemsbok is born early in the year. At birth, the calf's horns are nearly one inch long, bent backwards, and



'BUILT-IN" SPEARS

The fierce-looking horns of the gemsbok may actually reach four feet in length. Well-endowed for fighting, the gemsbok can impale its enemies on its horns, and, at the same time, be protected against severe injury because of the unusually tough skin on its shoulders. Even the kingly lion or a savage pack of dogs can be held off by the gemsbok.

knobbed at the points. The newborn calf's hue is a pale reddish gray, growing paler as the youngster increases in size. Its mother keeps it hidden in the bush for several months, until about the time the calf begins to change color; now it is ready to join the herd with her.

The gemsbok is one kind of a group of antelopes known as oryxes. Other oryxes are much like their big relative the gemsbok. The Beisa Oryx and the Fringe-Ear Oryx of East Africa have shorter horns than the gemsbok and lack the black flank stripes; otherwise the animals look much the same. The White Oryx inhabits the sun-baked deserts of North Africa; its horns are not straight, as in other oryxes, but curve strongly backwards. The animal is often hunted by the Arabs.

ADDAXES—MADE FOR A LIFE IN THE DESERT

The Addax, *Addax nasomaculatus,* is a native of the desert regions of North Africa and the Egyptian Sudan. This remarkable animal can go for months without water to drink; it also changes its color seasonally from sandy or brownish gray to reddish brown.

The addax is very much like the oryx in appearance, except for its horns and feet. Both sexes have horns, measuring some forty inches along the curve, but in the female they are more slender and less spirally twisted than in the male. Broad, spreading feet are adaptations for support on soft, sandy wastes. The addax associates in pairs or small herds and travels far over the desert in the wake of thunderstorms, which bring up quick growths of green vegetation.

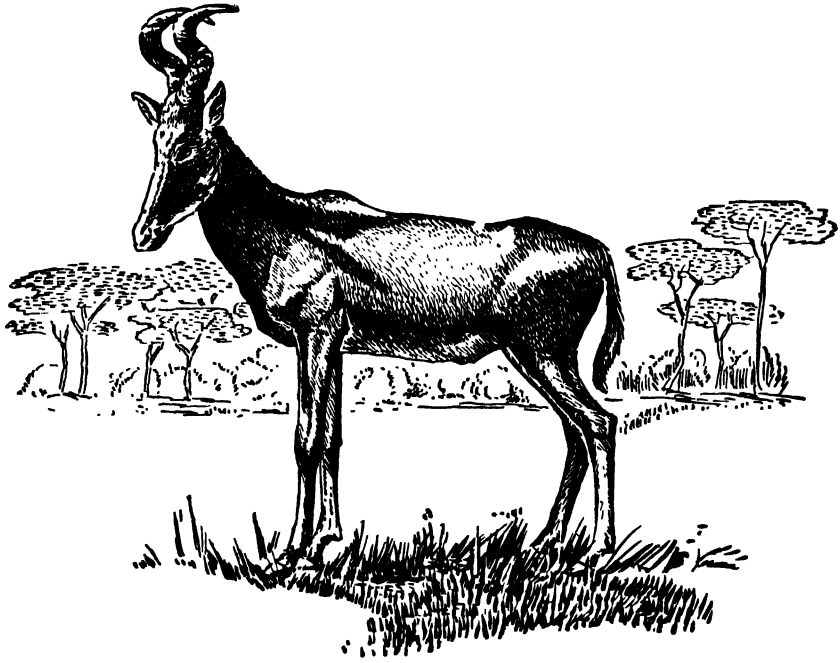
Like the white oryx, the addax is hunted by the Arabs, since it is a fairly sizable creature; it has a shoulder height of about forty inches. A large patch of black hair marks the forehead, while below it is a streak of white stretched across the nose. The hindquarters, tail, and legs are white.

ANTELOPES WITH LONG FACES

HARTEBEESTS—FAST AND TIMID

Society-loving creatures, hartebeests (the name is simply South African Dutch for "hart beasts") often associate in large herds in Africa. Preferring open plains and desert areas, where they seem to live almost independent of water, they feed exclusively on grasses, usually

during daylight hours. The hartebeest is of such a timid and retiring nature that it rarely attempts to defend itself, even when attacked or wounded.



A TIMOROUS CREATURE

Though the majestic hartebeest is one of the larger and faster antelopes, it shrinks from fighting. Even when it is attacked or hurt, it is too shy to retaliate. The fine figure of the hartebeest adorned ancient Roman coins, symbolizing the African holdings of the Empire.

Among the fastest of the larger antelopes, hartebeests move with a heavy gallop when first startled. Then they gain high speed as the apparent stiffness in the joints disappears and they vanish in a cloud of dust. When grazing, hartebeests seem to post a sentinel on a large anthill, where it has an extensive view of the surrounding bush-covered veld. And well may they keep a careful lookout; their flesh is much relished by the natives and the lions.

The hartebeest dwells throughout most of Africa south of the Sahara. There are many kinds of hartebeest. The Korrigum, and its relatives the Senegal Hartebeest and the Topi, are fairly large antelopes with a dark, reddish-brown, narrow face. The Bubal Harte-

beest, which stands about forty inches at the shoulder, has an abnormally long face. The Kongoni, one of the smaller hartebeests, is often seen in Kenya and Tanganyika. It is frequently shot for food. Both sexes of the hartebeest have ringed horns that are more or less lyre shaped.

ANTELOPES ON THE WANE

Rather rare today are the Blesbok and the Bontebok, beautiful antelopes with fine, glossy coats. Their faces are long and narrow, and atop them are rather short horns, heavily ringed and lyre-shaped, and curving slightly backward. Formerly widely spread over the northern plains of the Cape Colony, the Orange Free State, and the Transvaal, these creatures were extensively hunted in the past, so that we do not find them in many parts of their native South Africa at present.

The bontebok (its name means "spotted buck" in Dutch) wears a purplish-red coat, and has a white face and rump. The Blesbok ("blaze buck") has a white blaze or spot on the forehead, but is otherwise not very different from the bontebok. Both are closely related to the Sassaby, a large antelope with short horns that spread upward and backward in a crescent-shaped curve, and all are cousins of the better-known hartebeest.

WILDEBEESTS OR GNUS—WITH HEADS LIKE THE BUFFALO'S

Black Wildebeests—Fast Trotters with Amazing Endurance. The Black Wildebeest, or White-tailed Gnu, *Connochaetes gnou*, with its long-faced, buffalo-like head, is not only one of the queerest-looking of the antelopes—it is a fascinating animal to observe as it moves fleetly along the African veld. The wildebeests travel with a fast trotting pace, taking immense strides; they can keep this up for most of the day. Their call is curious, too—a loud, bellowing snort with a peculiar metallic ring.

When a herd is about to stop and have a look back, the leader, slowly cantering along, wheels around, followed by the herd in single file—but, not until the last one has made the turn, does the leader give the signal to pull up.

When a troop of wildebeests stop to face an intruder, it is not uncommon to see a pair of bulls or cows drop to their knees and start sparring furiously with each other for a minute or two.

Despite its habit of traveling a considerable distance to forage for fresh pastures where the grass is green, the wildebeest is really a homebody. In all its wide range it has some particular spot where it goes the year round to rest during the warm midday hours. When feeding, the black wildebeest frequently kneels, a posture that few if any other animals assume.

The black wildebeest's name is not quite accurate, for it is dark brown—dark enough to be almost black. A fierce-looking creature, rather horselike in build, it measures four feet at the shoulder—it is the smallest of the gnus. It has a long, flowing, bushy white tail, and an erect mane on the neck.

The horns, unringed, are directed downward, then abruptly upward in front of the face. A tuft of hair on the nose adds to its queer appearance.

Once common on the flatlands of South Africa, the black wildebeest used to be heavily hunted for its skin, and the animal has all but disappeared from the wild state. It is carefully preserved in the Cape Colony.

Blue Wildebeests—Spectacular and Speedy. Like its relatives, the Brindled Gnu, or Blue Wildebeest, *Gorgon taurinus*, travels in herds. Today it is a much commoner animal than the black wildebeest.

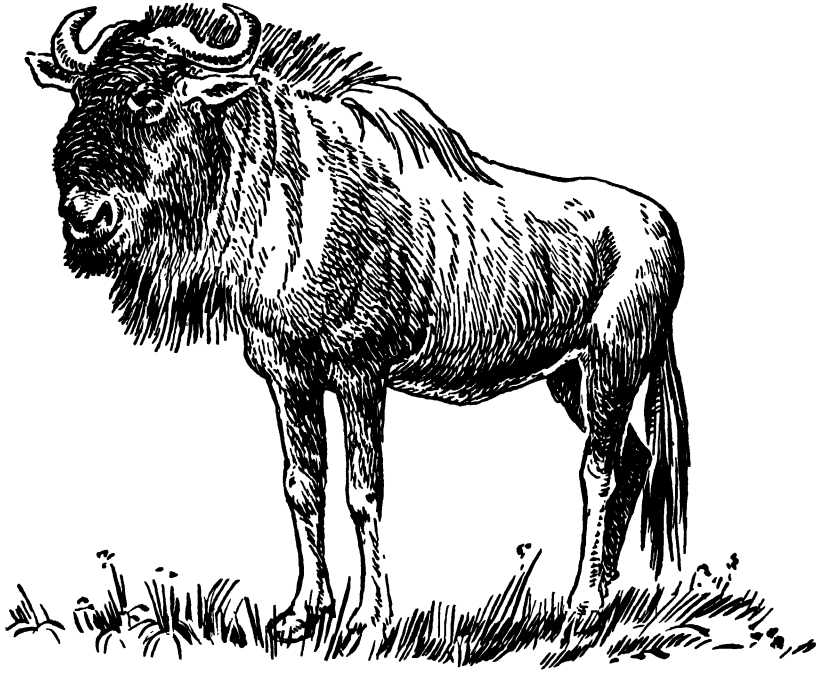
In general appearance a troop of brindled gnus resemble a herd of bison, from a distance, at any rate, and the behavior of both animals is very much alike. When stampeded, the gnus take off with a wild tossing of the head, combined with heel-kicking and tail-waving. At first they go into a fast trot, but after fifty yards or so they turn into an undulating gallop. There is much indignant snorting and grunting; their protests carry quite a distance.

In the long run the brindled gnu is one of the speediest animals—if not the fleetest of the lot—on the African veld. On the gallop it frequently travels in single file, often making a most spectacular picture along the skyline.

Cornered or hard pressed, the gnu will charge; still, it almost always stops short of its objective, trying to appear much more ferocious than it really is.

——HERDS IN THE HUNDREDS. Brindled gnus travel in groups of anywhere from a dozen to several hundred animals. They frequent the open plains, where their favorite food is grass. Fast as these ante-

lopes are, some authorities believe that a brindled gnu can be overtaken by an exceptionally fleet horse. Dependent on a regular supply of water, wildebeests migrate from one drinking place to another.



THE GROTESQUE GNU

Strangest of the antelopes, both in appearance and behavior, is the gnu or wildebeest, of Africa. It has a body like a horse, a long, melancholy face, bunches of hair on its neck and throat, and a bushy tail. This animal will often behave quite belligerently when aroused. It is a sharp-sighted creature, and very wary of man.

The brindled gnu is bigger than its black cousin—it measures four and one-half feet at the shoulder, and weighs up to 550 pounds. Brindled in color, this gnu has brown stripes on the neck and shoulders; its tail is black. The smooth horns spread outward instead of forward. This animal dwells for the most part on the open plains of central and eastern Africa north of the Zambesi River.

Wildebeests mate from June onward. The cows separate from the bulls when the calves are born eight and one-half months later. Cows usually have one calf at a time.

GAZELLES AND THEIR RELATIVES

The Gazelle, *Gazella,* is a slender, beautifully formed small antelope with high-tension muscles that can send it hurtling across the barren wilderness at an incredible speed. Although it is among our most comely and graceful animals and lives in accessible and well-traversed regions, the gazelle has had surprisingly little mention in literature. No one seems to have made a detailed study of its life history.

WHERE THE GAZELLE LIVES

The gazelle is at home in the hottest and driest parts of the Old World. It is a creature of the burning deserts, treeless plains, and sandy wastes. That there is no water for miles and miles around, and not a vestige of shade in which to shelter itself from the torrid heat of the midsummer sun, does not inconvenience this lover of the great open spaces.

FLEETER THAN THE CHEETAH

The cheetah is perhaps the only mammal that can catch a gazelle in a straight run. But this holds only for the cheetah's first burst of speed—and even so, it must get within a reasonable distance before the race begins.

Arabs train the speedy Saker falcon to swoop down upon the gazelle and strike it a stunning blow on the head. This gives the hunters, on their fast horses, a chance to catch up. In Asia, the natives hunt the gazelle with gazelle hounds, but few dogs can be expected to match the speed of a full-grown gazelle. Both greyhound and falcon are employed in the capture of the gazelle, and in some cases both hawk and hound are trained to work together.

WHAT GAZELLES LOOK LIKE

We find sixty or so different kinds of gazelles in southern Asia and northern Africa. Most of these creatures of the stony plains or deserts are comparatively small, not more than about two or three feet at the shoulder. For the most part, they have lyre-shaped, ringed horns that curve backward and upward (they are generally larger in the male,

and the females of a number of species lack them). Their coat is sandy brown in color, which makes them inconspicuous in desert regions. In many cases, the animals have black and white bands on the face and flanks.

"GAZELLE BOYS"

Earlier in this book we mentioned some strange stories of children who are said to have wandered off or been abducted and reared by four-footed foster mothers. Stories of this nature have been told so frequently that they have found a place in romantic literature and are prominent in folklore. None that has become known in our time has stood up under scientific investigation.

One of the most amazing of these stories concerns a "gazelle boy" —it got world-wide publicity in newspapers and magazines. It was in



SWIFT AS THE WIND

The delicate, sprightly gazelle is one of the fastest mammals on earth. None but the cheetah, the greyhound, or the hawk can overtake or capture it. Gazelles are often found on hot, burning deserts, where they live without water or shade nearby; however, the Tibetan gazelle, or goa, pictured above, prefers grassy plains.

September, 1946, that the newspapers carried headlines such as this one: "Fast Gazelle Boy Chased by Car for Two Hours." According to the newspaper account, native hunters on the Syrian steppes found a boy running wild with a herd of gazelles. To make it all the more convincing, there were pictures of a naked native boy, about fourteen; he looked like a perfectly healthy child.

Prince Fawaz el Shaalan, leader of a Transjordanian desert tribe, who captured the "gazelle boy," said: "We were hunting gazelles in the desert by car, when suddenly I saw a human form among these graceful beasts. I ordered my companions to cease firing and we pursued the form. Although we were in a car, it took two hours to catch up with the boy, who fell down exhausted.

"A physician who examined the boy at the Baghdad hospital said this child acts, eats, and cries like a gazelle, but there is no doubt that he is a human being who was brought up by the gazelles after having been abandoned by his mother."

This might have gone down in history as another unexplained mystery. However, later investigation indicated that the boy, mentally deficient, was probably the son of a Bedouin family living in the neighborhood.

Other "gazelle boys" subsequently turned up in Trans-Jordan, Iraq, Syria, and Lebanon. In no case had these children actually been raised by animals. Still, many people readily accepted the tales about them.

GERENUKS—THEY STAND ON THEIR HIND LEGS

The Gerenuk, or Waller's Gazelle, *Litocranius walleri,* is noted for its ability to feed while standing on its hind legs. This it does frequently in order to reach the leaves on which it dines. It has a further adaptation for this form of eating—its extraordinarily lengthy slender neck, and legs that are very long for the size of its body.

The males carry twelve-inch horns that curve forward toward the tip and are heavily ringed. The general color of the gerenuk is reddish brown, with a broad darker band down the middle of the back.

The typical gerenuk dwells in East Africa from Jubaland to Uganda and south to the Kilimanjaro district.

GOITERED GAZELLES—THEIR THROATS SWELL AT MATING TIME

The Goitered Gazelle, *Gazella subgutturosa,* has a spectacular speed for an animal its size (about twenty-six inches at the shoulder). We have reason to suppose that in full flight the goitered gazelle can reach a speed of sixty miles per hour. It can run at an average of thirty miles per hour for a distance of ten miles, and it can easily pull ahead of a car doing forty miles per hour.

The latter part of this animal's scientific name was derived from the swollen condition of the male's throat during mating time.

The goitered gazelle wears a coat of very dark cinnamon, but most of the head is white or buffy white, while the tail is black. Usually only the male has horns—they curve backward with an upward swing; as in most gazelles, the horns are ringed. The females are hornless or almost so, with mere short stubs passing for horns.

Asia Minor to the Gobi Desert. The goitered gazelle is a desert-loving creature that associates in small herds. It has its home farther north than any other of the typical gazelles. Its immense range extends from Asia Minor and the Caucasus through Russian Turkestan, Syria, Iran, and Afghanistan to the Altai Mountains and the Gobi Desert. Sometimes the animal is kept by the Arabs in tame herds.

SPRINGBOKS—THEY FLASH SIGNALS

The Springbok, *Antidorcas marsupialis,* derives its common name from its peculiar habit of leaping in the air at most unexpected times. It is gazelle-like in general form, with perfect lyre-shaped horns that curve inward evenly at the tip.

This gazelle stands about thirty inches at the shoulder and weighs from seventy to eighty pounds. Especially noteworthy about it is a fold of skin which it has on its back. When alarmed, the animal turns the fold inside out, displaying an array of white hairs. These hairs probably serve as a warning signal.

There was a time when the graceful springbok gathered in immense herds on the plains of South Africa north to the Orange River. Thousands used to be seen trekking in search of good forage but persistent hunting has greatly reduced the numbers and range of the animals.

Good Samaritan. E. M. Menmuir gives us a picturesque account of an actual incident which shows the sympathetic feeling of a springbok for an unfortunate neighbor. It seems that while marooned in dune veld south of the Kalahari, a lawyer and his wife heard a low, whimpering sound coming from the dunes. Presently a springbok showed up, followed by a wildebeest which was evidently in a bad way.

Apparently the springbok was leading the wildebeest, for every time the wildebeest made the whimpering sound the springbok would wait for it and then nose it gently along. Later it was found that the wildebeest was quite blind, evidently from the venom of a snakebite.

KLIPSPRINGERS—JUMPERS AND WHISTLERS

The Klipspringer, *Oreotragus oreotragus,* is a mountaineer that invariably is found on rocky slopes in Africa from the Cape of Good Hope to Ethiopia. An alert little creature, continually on the lookout for enemies, it trusts rather to seeing its enemy first than to escaping detection. When it is not unduly alarmed or when its curiosity is aroused, the klipspringer will utter a shrill whistle.

When disturbed, the klipspringer always retreats uphill, taking what advantage it can of bush and rocky cover. Reaching the summit, it will pause, silhouetted against the skyline, for a final backward look. Against the rocks and bush, its protective coloration makes the klipspringer almost imperceptible even when in full view.

The "African Chamois." The klipspringer's agility in its precipitous rocky home has earned for it the name of "African chamois." It can obtain a foothold on a rocky projection the size of a quarter; when it is agitated, it fairly bounces up almost perpendicular cliffs like a rubber ball.

Though the klipspringer loves company, it is not gregarious; two or three often associate together, and sometimes as many as eight—but scarcely ever more—will maintain a group in a small area. They feed both by browsing on leaves and shoots of shrubs and by grazing on grass.

This dainty little animal is about twenty inches high at the shoulder. The horns of the bucks are ringed at the base and rise almost straight up from the head, bending only slightly forward. The females are generally hornless. As for the klipspringer's large, cylindri-

cal hoofs, they are more like the feet of a mountain goat than those of an antelope. The hair, too, is peculiar, being long and brittle, with a pithy structure resembling deer hair. The klipspringer's general body color is yellowish brown speckled with yellow. The animal makes an excellent pet, being very playful and fond of showing off its ability to jump.

ORIBIS—THEY HIDE IN TALL GRASS

The Oribi, *Ourebia ourebi,* the swiftest of the smaller antelopes, is as much at home in the rolling foothills as it is on the plains. When first disturbed, it takes off across the plains in a low, running gallop. At a safe distance, it springs into the air, each time coming down on its hind legs first.

Though the oribi wanders freely over the open plains, it is primarily a creature of tall grasses and bush country. Here it lies so close that it will almost permit itself to be stepped on, hoping to escape detection. When it does move, it goes with a tremendous rush, leaping in the air to see any danger that may be ahead.

A graceful creature, the oribi is yellowish brown in color, and can generally be recognized by the long tufts or brushes on its knees. The male has straight, ringed horns, about six inches long, that project upright from the head.

In the bush, the oribi lives in twos and threes but on the open plains ten or twelve individuals may be seen feeding together. Alarmed, they disperse in all directions—there is no unity in the group.

The oribi's range extends from South Africa to Ethiopia.

STEINBOKS—ANTELOPE OF THE OPEN SPACES

The Steinbok, *Raphicerus campestris,* is one of the few African game animals that have persisted over much of their ancient range despite the encroachment of man. It lives either singly or in pairs and is never sociable.

The steinbok, as a rule, favors open plains broken by scattered bush. Though it is at home on stony ground, it never takes to the mountains, nor has it been seen on steep hillsides. Passing the day hidden in tall grass, it comes out to feed during the evening and early morning hours. It is most conspicuous in the open spaces, where, for

safety, it relies upon its ability to speed away. When hard pressed by dogs, however, it occasionally takes refuge in an aardvark burrow underground.

Not unlike the oribi in appearance, the steinbok has larger ears and a longer tail. Its body is sandy-reddish, with the head a darker shade; the shoulder height is about twenty-two inches and it weighs twenty-five pounds. Generally found in the plains of South Africa, the steinbok ranges north to the Transvaal and Kenya.

GAZELLES ARE A GREAT RACE

The Old World has gazelles in such abundance that we cannot hope to look at all of them here. But a few more are definitely worth a passing glance. The Addra Gazelle, *Gazella dama,* also known as the *nanger, dama,* and *mhorr,* is the largest of the gazelles. It stands thirty-seven inches at the shoulder and has a longer neck than most gazelles, but its horns are rather short. Native to the desert regions of North Africa, it is easily recognized by the white rump patch which includes the tail.

Grant's Gazelle, one of the larger varieties, is the best-known gazelle found in East Africa. An attractive creature, it stands thirty-three inches at the shoulder and weighs 150 pounds. Both sexes have long, handsome, lyre-shaped horns which measure about thirty inches in the male, only seventeen in the female. This animal ranges from Tanganyika north through Kenya and Ethiopia, and travels in herds; often it is seen near water holes, in easy fellowship with other animals.

The Goa is a famous gazelle of the Asiatic plains, deserts and upland plateaus, where it sometimes falls victim to wolves. In India the Chinkara, or Indian Gazelles, are the best known and most widely spread of the gazelles. These fawn-colored animals stand about two feet at the shoulder; they are much hunted with dogs and golden eagles.

The Atlas Gazelle is a small creature native to the higher ridges in Morocco, Algeria, and Tunisia, where it is known as the *admi* or *edmi.* Another small antelope, the Dorcas Gazelle, occupies the hot deserts and barren wastes of Palestine and Syria as well as the burning sands of North Africa to the Anglo-Egyptian Sudan and the Sahara.

The Rhim is the gazelle of the Libyan desert and the sand dunes of Algeria and the Sahara. Its color is a very pale sandy, appearing

almost white in the distance. The Korin is the Red-fronted Gazelle of Equatorial Africa, Senegal, the northern Cameroons, and the Anglo-Egyptian Sudan. Speke's Gazelle, a native of Somaliland, is peculiar in that it has a flabby corrugated elevation on its nose. A gazelle fast approaching extinction is the Red Gazelle, of the Algerian Sahara.

Thomson's Gazelle, a small, graceful animal with well-developed white facial markings and a narrow black band bordering the white on the sides of the rump, is familiar to every sportsman who visits Kenya and Tanganyika Territory. Heuglin's Gazelle is another variety with sharply defined flank stripes.

DWARF ANTELOPES

The Royal Antelope, *Nesotragus pygmaeus*, is not only the smallest antelope in Africa but one of the smallest hoofed mammals in the whole world. Only ten inches at the shoulder, it has horns less than one inch long. This pygmy lives in the forests of the West African coastal region from Liberia to Nigeria. It has a close relative in another pygmy antelope—the Suni, *Nesotragus moschatus*. This attractive little animal of the forests of East Africa stands just about a foot at the shoulder.

The Dik-Dik, a tiny slender antelope not much bigger than the royal antelope or the suni, is about fourteen inches at the shoulder and weighs six or seven pounds. This handsome, harelike animal favors semiarid brush country and, when disturbed, it bolts through the underbrush like a rabbit. Every year, thousands of dik-diks are captured in nets and killed for their skins, which are made into ladies' gloves. The animals are found in many parts of Africa.

OTHER INTERESTING ANTELOPES

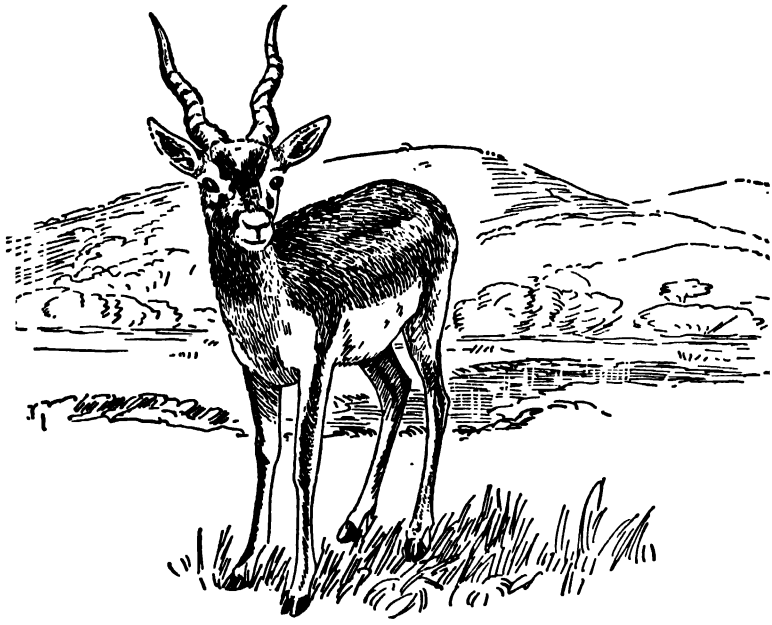
Another interesting little creature is the Somali Beira, or Beira Antelope, a big-eared, grayish-fawn antelope with large feet bearing globular pads. Its shoulder height is about twenty inches, and it weighs in the neighborhood of twenty pounds. Its spike horns are four inches long. Beiras are scarce, but they may be seen in twos or fours in the arid mountain regions in the interior of Somaliland and Ethiopia.

When they hear a disturbing sound, they will often leap atop a high rock and try to see whether there is any cause for alarm. If there is, they are off in a flash.

BLACKBUCKS—INDIA'S FLEETEST ANTELOPES

The Blackbuck, or Indian Antelope, *Antilope cervicapra,* is the fastest of India's antelopes—it can leave a pair of greyhounds far behind. Credited with a speed of fifty miles an hour, this handsome antelope can be overtaken by a cheetah only in that animal's first lightning-swift burst of speed. On one occasion a blackbuck was run down on horseback, but a very fast Arabian horse was used; this feat has not been repeated, so far as we know.

Herds of Ten to Thousands. Open plains are the favorite haunts of the blackbuck. These abundant animals travel in herds generally



A STARTLING CONTRAST

The beautiful blackbuck or Indian antelope has a strikingly colored coat—shiny black on top, pure white underneath. Twisted, ringed horns rise from its head in a broad V-shape. For many years, this animal was common game in India, and was widely hunted. Today, it has become so scarce that it has to be protected by law.

numbering from ten to thirty; but we do have records of vast herds of several thousand of both sexes and all ages being seen together. The blackbuck never enters the forest or tall grass country. A grazing animal, it feeds on short grasses; often it lives in regions where it is impossible to obtain water.

Occasionally the blackbuck roams across cultivated land, doing damage to the crops. Should the antelope be startled, it will leap high into the air again and again. Then away it speeds, displaying the fleetness of foot for which it is famous.

Blackbuck Horns. The blackbuck is readily distinguished from all other antelopes by its beautiful horns; ringed and spirally twisted, they spread out from the top of the head in the form of a broad V. The record horn length is twenty-nine inches. As a rule only males have horns—occasionally an old female will be the exception.

Adult bucks are black or blackish brown, while the females and young are reddish fawn in color. Standing thirty-two inches at the shoulder, the blackbuck weighs about eighty-five pounds. As we have noted, this splendid creature is the only "true" antelope—at least according to its scientific name. It is the common medium-sized antelope of India.

IMPALAS—CHAMPION HIGH-JUMPERS

The Impala, or Pallah, *Aepyceros melampus,* is one of the most graceful of a race of graceful creatures. The cover in which the impala lives is sometimes dense; more often the animal sticks to parklike country, where it can feed in open glades. It always chooses a location where water is close at hand. During the heat of the day it rests in the shade of trees, usually lying down.

The impala is a great traveler; nomadic in habits, it usually travels along river courses. When a herd is alarmed, the animals bound off, sailing over the bushes and rocks with little apparent effort, and disappear in the recesses of the forest. In jumping, the impala seems to float through the air in graceful undulations very different from the springlike action of most antelopes.

For a limited distance the impala is perhaps the fleetest of all antelopes—not only does it bound over bushes and rocks, but often over its companions as well. One observer saw an impala cover a horizon-

tal distance of seventy feet in three successive leaps—one leap alone measured thirty-five feet. The impala has been known to clear an eight-foot wire fence. It is easy to approach these unsuspicious creatures—unless they have become wary from frequent persecution.



AN AMAZING LEAPER

Famous for its high jumps over rocks and bushes, the impala easily vaults over an eight-foot barrier. When it takes off, this nimble creature soars through the air with the grace of a bird, rather than like a hoofed animal.

An impala herd on the run presents a graceful and eye-filling picture. Although the animals love company, they rarely gather in herds of more than fifty. Both sexes live together in the winter months, when the herds are at their largest. In the summer, they travel far afield and live in scattered bands of one young male with fifteen or twenty ewes. He may have to fight for his harem from time to time, but is generally able to withstand the attacks of older bucks.

The impala's coat is reddish gold, the under parts are white. Only the bucks have horns—ringed and lyre shaped, they measure fourteen to twenty inches in length. The animal stands about three feet at the shoulder and weighs up to 160 pounds. The impala, although often the victim of packs of wild dogs and other flesh-eaters, is still found throughout much of its former range in Kenya Colony and Tanganyika, with a related form in Southwest Africa and Angola.

DIBATAGS—ANTELOPE ODDITIES OF SOMALILAND

The Dibatag, *Ammodorcas clarkei,* is also called Clarke's gazelle, after the Westerner who discovered it in 1890. This strange-looking antelope has a very long neck and legs, and a thin, lengthy tail tipped with black. The animal stands three feet at the shoulder and wears a coat deep cinnamon in color; it has white marking on its face.

A swift creature, the dibatag has a curious way of running. Neck and tail work like scissors when the dibatag speeds along: the head is repeatedly swung well back, then forward, and at the same time the tail is arched forward, then back. Apparently it was for this habit that the creature was named—dibatag means "tail raising" in Somali.

Only the male dibatag has horns—they measure about twelve inches in length and project upward and forward; ringed on the lower portion, they resemble the horns of a reedbuck.

The dibatag is a fairly rare antelope, living in small family groups among the parched sands of central Somaliland. It does not appear to require water, but depends upon plant food for its liquid.

Goat Antelopes—Neither Goats Nor Antelopes

THE GOAT ANTELOPES—the Rocky Mountain goat, the chamois, the musk ox, and their relatives—share in varying degrees the features which we find in goats and antelopes. Yet they are neither of these, and so we place them in a group by themselves.

Some of the goat antelopes enjoy living in more or less splendid isolation on remote mountain crags, at dizzying heights which sometimes range up to eighteen thousand feet. Others dwell in dense mountain forests, also at considerable elevations.

The thick-haired hides of the goat antelopes protect them from the rigors of the freezing temperatures that prevail in their favorite haunts. And, too, their hoofs are generally adapted in some way to give them the extra-sure footing without which they would soon perish. The animals are cud-chewers, and belong in the same family (Bovidae) as the oxen, true antelopes, true goats, and the sheep.

ROCKY MOUNTAIN GOATS—AT HOME ON PERILOUS PEAKS

The Rocky Mountain Goat, *Oreamnos americanus*, with its white coat and slender, backward-curving horns, looks for all the world like a true goat, yet it is a closer relative of Europe's chamois. A hardy creature, it is very much at home among the rugged cliffs and mountain peaks high above the timber line; not even the icy blasts of winter can induce it to seek the shelter of friendly woods.

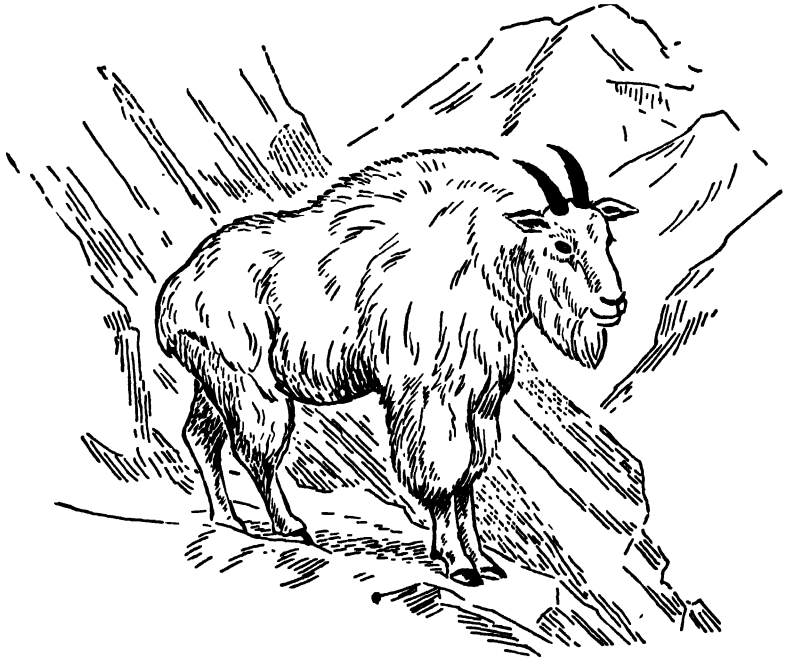
From broken crags and treacherous mountain ledges the Rocky Mountain goat complacently views the world beneath. It never hastens its pace—in fact, it has no need of haste, for few natural enemies can follow the steep trail where the mountain goat picks its sure-

footed way, as it forages for the foliage, moss, lichens, and other plants on which it feeds.

UNEXCELLED FOR VALOR

This goat antelope can guard itself against almost any manner of four-footed foe. Sometimes the cougar, golden eagle, wolf, or bear may attack it, but then, too, even the great grizzly bear has appeared on the list of animals the Rocky Mountain goat has slain.

Arthur B. Fenwick, a field naturalist, gives amazing proof of the mountain goat's unexcelled valor: "A goat will sometimes kill a full-grown silvertip [grizzly] bear. I once found a big goat dead, which evidently had been killed by a silvertip, as there were lots of tracks all around, and the goat's back was broken. I thought it queer that the bear had not taken the goat away and buried it, as usual, so I



MISNAMED A GOAT

The goat antelopes are a separate group of animals, possessing traits found in both goats and antelopes. The Rocky Mountain goat, shown above, is a member of this group—it is not really a goat at all. Yet, like the goats, it is a superb climber, able to scale steep crags and dangerous precipices.

looked around. I found a large silvertip bear dead, and all bloated up; and when I examined him, I found that the goat had punched him twice, just back of the heart. He had been able to kill the goat, and had then gone off and died."

A Frightened Mountain Goat. The same writer tells of the only time he every saw a mountain goat really frightened:

". . . When near the summit of a mountain in British Columbia a bear passed through a little pass near a pinnacle of bare rock, about two hundred feet high. He frightened an old long-bearded billy-goat, who immediately started up the pinnacle as hard as he could go and climbed near to its summit. And there the old fellow stood, or rather hung, in a most ridiculous attitude. His front feet were hooked over the eastern edge of the point, like a man looking over the peak of a steep house-roof, and holding only by his hands. His body and hind legs were well down the other side of the pinnacle, and completely overhung a frightful precipice."

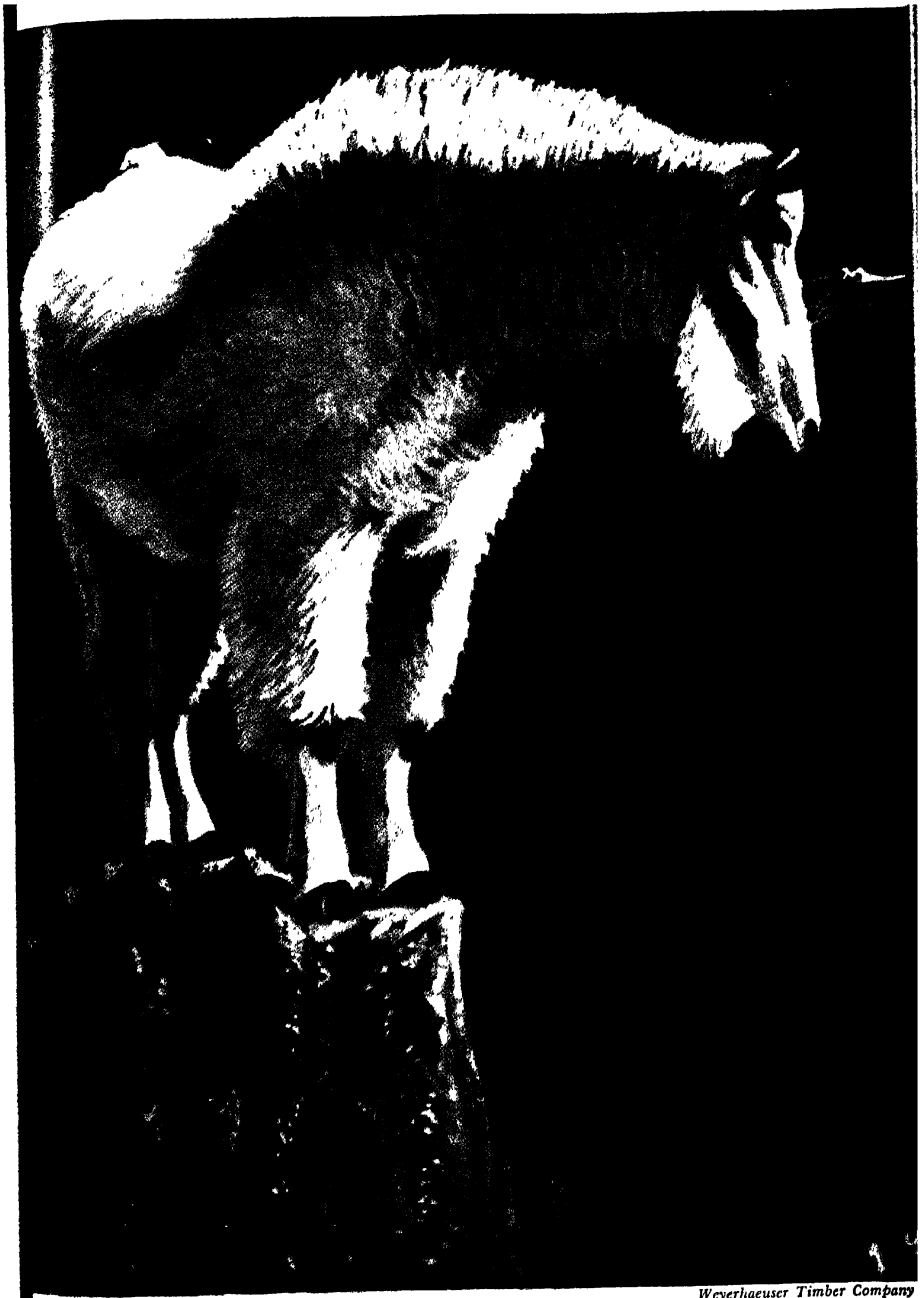
The goat, however, never lost its hold, according to Fenwick. When the menace had passed, the animal made its way to safety.

THE MOUNTAIN GOAT'S WORST ENEMY

Nature itself is the most dreaded enemy of the Rocky Mountain goat. Spring thaws bring engulfing cataracts of snow and rock slides; winter storms may build masses of snow twenty feet deep that crash down the mountainside and envelop everything in their path. When the first thundering roar of an avalanche breaks the silence of the desolate wastes, the Rocky Mountain goat moves into action and climbs steadily upward to safety at the top of the nearest peak.

ROCKY MOUNTAIN GOAT FAMILIES

We know little about the breeding habits of the mountain goat; humans seldom venture into its cold and bleak haunts during the breeding season in November. In April or May one or two kids come into the world. A kid born in captivity weighed seven and one-half pounds two days after birth, and measured thirteen and one-half inches at the shoulder.



Weyerhaeuser Timber Company

AT HOME ON THE STEEPEST CRAGS

Lofty mountain ranges are the home of the Rocky Mountain goat. Here few enemies can even approach it, and its shaggy white coat protects it from the winter cold. As it scrambles amid rocks and snow during the spring thaw, it must be ever alert to the danger of avalanches.

The "billies" or males are usually seen in twos and threes; if there are several goats in a group, they are generally "nannies" and kids. However, both parents may remain together while the young are very small; this is all to the good, as there is some danger that one of the babies may be stolen in an unguarded moment by a golden eagle.

SYMPHONY IN WHITE AND BLACK

The mountain goat is white except for the black hoofs and the ebony daggerlike horns, which measure ten inches in length. A stout-legged creature, the mountain goat has shoulders that are higher than the rump, giving it a hunchback appearance; some of the early pioneers referred to this shaggy creature as a small white mountain buffalo.

A full-grown male mountain goat stands between thirty-five and forty inches at the shoulder and weighs from 150 to three hundred pounds. The females are smaller than the males, but both sexes are horned and bearded.

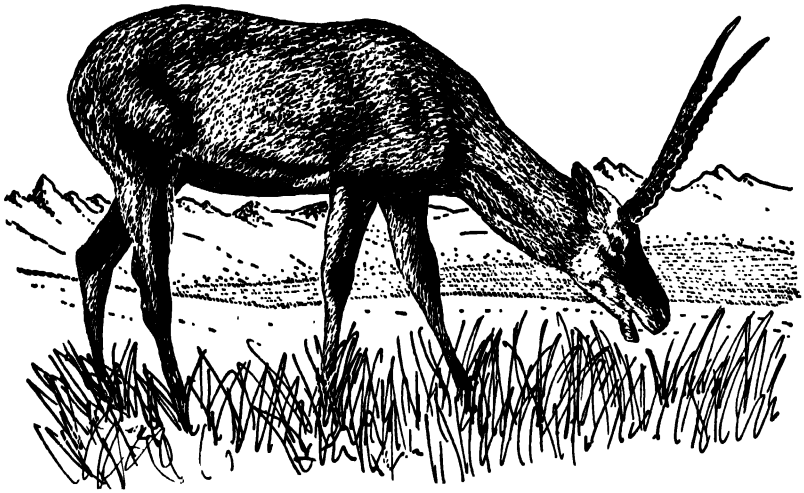
There are four named forms: the Cascade Mountain Goat, the Alaska Mountain Goat, the Columbian Mountain Goat, and the Montana Mountain Goat. As you can gather from these names, the home range of the mountain goat covers the peaks of western North America from central Washington State and Idaho northwest to southern Alaska. Although the animal is not difficult to hunt once the sportsman gets within range of it, the rugged and remote nature of its homeland will apparently vouch for its survival indefinitely.

CHIRUS—HEAVY COATS FOR COLD CLIMATE

The Chiru, or Tibetan Antelope, *Pantholops hodgsoni,* is native to the plateau of Tibet; here, at elevations of twelve thousand to eighteen thousand feet, this robust goat antelope wanders about on its sharp-pointed hoofs. As an adaptation to a cold climate, the chiru has a very thick, full coat of erect hair, pale fawn in color, that is woolly next to the skin. Peculiar swellings on each side of the animal's muzzle may serve as some sort of air conditioner—the animal certainly has need of one in the icy Tibetan winter months.

The female chiru is hornless, but the buck has horns that are black and ringed; with a two-foot maximum length, the horns bend forward slightly and away from each other. When seen in profile,

the chiru's horns suggest a one-horned animal; the chiru is classed as one of the creatures that may have given rise to belief in the fabled unicorn.



IT WEARS A THICK WOOLLY SWEATER UNDER ITS COAT

At elevations of twelve to eighteen thousand feet, the chiru or Tibetan antelope needs maximum protection against the icy temperatures. Such protection is provided by its soft, extra-warm coat. The coat is smooth on the surface, but underneath, next to the skin, it is made up of densely enmeshed fine hair which traps the air and keeps it warm.

The Unsociable Chiru. The chiru keeps to the plains or open valleys, usually hiding out during the day in hollows on the flats. Formerly groups of several hundred were not uncommon, but now herds consist of only a few individuals. The chiru mates in winter, and a single baby is born six months later. Except during the mating season, the sexes live apart. The animal stands about thirty-two inches at the shoulder, and weighs up to 120 pounds.

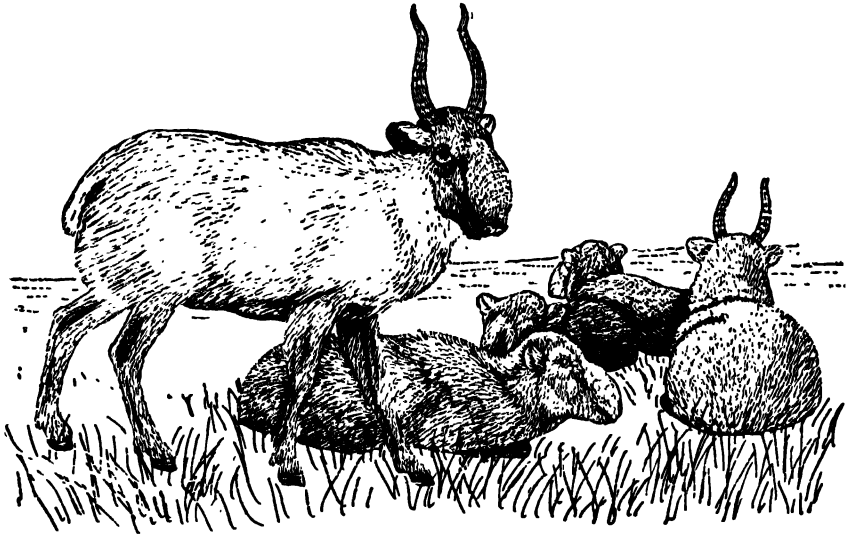
SAIGAS—GOAT ANTELOPE ODDITIES

The Saiga, *Saiga tatarica,* is the strangest looking of all the goat antelopes. This horned, sheeplike creature runs with lowered head, like a sheep or ox; its enormously swollen nose strongly suggests the moose. It is thirty inches tall at the shoulder but has fairly short legs.

Dust Filters. The saiga lives on alkali flats and vast stretches of open steppe country in central Asia, where it encounters severe dust and

sand storms. As in the chiru, the many small hair-lined channels in the muzzle doubtless serve to filter the particles of dust and sand from the air which the animal breathes, and warm the air during the cold months. During the summer the harsh, thick hair is dull sandy-yellow in color; in winter it becomes almost white, reminding us very much of a sheep's coat.

Bootleg Horns. Only the male saiga bear horns. Slightly lyre shaped in form, ringed in front, and pale amber in color, they are only about half as long as the chiru's. Still, they are in great demand among the Chinese for "medicine." Despite rigid controls imposed by the Russians, there is considerable bootleg trade carried on in saiga horns, since they are valued at 250 dollars a pair.



THE SAIGA HAS A HIGHLY SPECIALIZED NOSE

The saiga's homeland is the wide, open plains of central Asia, severely cold in winter, harsh and dusty in summer. One of nature's marvelous adaptations for life in such a setting is the saiga's ugly, bulging nose. It has many small channels which warm the air before it goes into the lungs, and the animal's nostrils are lined with tiny hairs to filter out the dust. The wary saiga is considered a most difficult creature to stalk.

Formerly the saiga ranged from Poland and the Kalmuck steppe of southern Russia to the Gobi Desert, and, in the early days, the Kirghiz tribesmen trained golden eagles to catch the saiga as well as the gazelle and the wolf. Today the saiga is more or less limited to the deso-

late wastes north of the Aral Sea, and a small herd exists under government protection on an island in the Aral Sea.

STRANGE HUNT

If the saiga is a strange animal, the people in its homeland are equally strange, at least by our standards. Once the author traveled in Russian Turkestan to collect a group of saiga for the American Museum of Natural History. His caravan traveled some two hundred miles across steppe and desert, and still there was no news of saiga. The Russian official who accompanied the expedition was not inclined to see its purpose frustrated. Highhandedly he arrested a wealthy Kirghiz nomad and sent him off under guard with instructions to bring back an experienced saiga hunter, "or else."

Five days later, the captive returned with a fierce-looking barbarian in tattered clothing. The newcomer was riding a shaggy desert pony and carried a long, old-fashioned gun with a forked stick that served as a gun rest. This cagey stranger never allowed the party to get a glimpse of the saiga—apparently the animal was to be his prey alone. Somehow, one day, he managed to steal away in the early morning. Later, he returned. There was a satisfied expression on his face as he pointed to the dead beasts slung on his horse—one fine male, a female, and several half-grown saigas.

GORALS—WITH VALUABLE BONES

The Goral, *Naemorhedus,* which ranges from the Himalayas to eastern Siberia, is at home on grassy slopes as well as scrub forests and rocky mountainsides, at altitudes of three thousand to nine thousand feet. It is highly esteemed by the natives, who snare the animal for its bones; these, like the saiga's horns, bring a high price for use as "medicine" in the Chinese markets.

This "chamois of Asia" is not so big as its European cousin. A stocky, goatlike animal (it stands twenty-eight inches at the shoulder and weighs about sixty pounds), the goral wears a coarse coat of gray or brown, and its short horns curve slightly to the rear. The animal is not easily seen in the tall grass; when alarmed, it makes a rather penetrating hissing noise which may be heard in places where there is no other sign of the goral's presence.



ITS BONES ARE USED IN QUACK MEDICINES

In Asia, there is a primitive belief that the goral's bones hold special medicinal powers. Handsome prices are paid for these parts, providing incentive for natives to hunt the animals. Observers say that the goral plays a clever hiding game on grassy slopes.

SEROWS—"CLIFF DONKEYS"

The Serow, *Capricornis sumatraensis,* is larger and stockier than the goral, often attaining a weight of two hundred pounds. To find this creature, you must make a stiff climb to the steep cliffs and rugged crags three thousand or more feet above the plains. In fact, the serow has been found at elevations of thirteen thousand feet.

Even after such an arduous climb, it is still far from easy to trace the serow. After days and days of stalking, a hunter may be rewarded by nothing more substantial than a loud, angry, shrill, whistling snort

in the thick bush and a momentary flash of the beast as it makes off through the thickets, covering fifteen or twenty feet at a bound.

The Chinese native name for the serow is *Ngai lii-tze*, meaning "cliff donkey"—a reference to its long ears and love for rugged country. During the rutting season, the rams have a habit of horning trees; this accounts for the smooth surface of the horns. Pursued by dogs, a ram will put up a terrific battle, unhesitatingly attacking man when cornered. The serow takes readily to water and can swim well. Chinese fishermen have seen this animal breasting the waters of the broad Yangtze.



THE DONKEY-EARED SEROW

An elusive animal, the stocky serow of East Asia lives on steep, bushy cliffs, at extremely high elevations, and is almost never seen by man. When tracked down and wounded, it may charge forth and become a serious menace. Natives call the serow "cliff donkey"—an apt name for this rock-climber with the big ears.

More or less solitary in their habits, the serows generally frequent the forestlands on the mountain slopes of northern India, Burma, southern and western China, Formosa, and Japan. In some places they have reddish coats, in others blackish-brown.

CHAMOIS—PRIZED QUARRY OF THE HUNTER

The Chamois, or Gems, *Rupicapra rupicapra,* is a goatlike mountain dweller found high above the timber line. An elusive, swift-footed small creature, it is one of the most difficult of animals to come to close quarters with. It is with no small pride that the Swiss or Austrian hunter wears on his hat a tassel of hairs taken from the chamois.

CHAMOIS SKIM LIKE BIRDS

A band of chamois, disturbed by hunters, need no path or ridge to follow. They skim like birds over wide ravines and dizzy peaks; their dainty feet have cup-shaped depressions which enable the animals to



AN ELUSIVE QUARRY

The chamois, a popular sport animal of the Alps, is no easy creature to kill. Its extraordinary feet, with their special gripping action, enable it to make high leaps and to land safely on treacherous mountain ledges. A broad jump of twenty feet is no record for the chamois. It is extensively hunted for its tasty flesh and valuable hide.

shoot down rocky chimneys and come to rest on tiny ledges no bigger than a man's hand. In winter the chamois leaves the cold, bleak heights to take refuge in lowland woods and sheltered valleys.

More slender than the sheep and the average goat, the chamois is easily recognized by its horns. Round and short, the horns rise perpendicularly from the head, and the tips are hooked abruptly backward and downward. Both males and females are horned.

In summer the chamois wears a coat that is soft tawny in color; in winter, it changes to blackish brown. Males are larger than females, and may reach a shoulder height of thirty-two inches, a weight of sixty-five pounds; females weigh about forty-five pounds. Formerly the soft, pliant leather known as "shammy" was made from the hide of the chamois; today the sheep and the goat are the common source of this product.

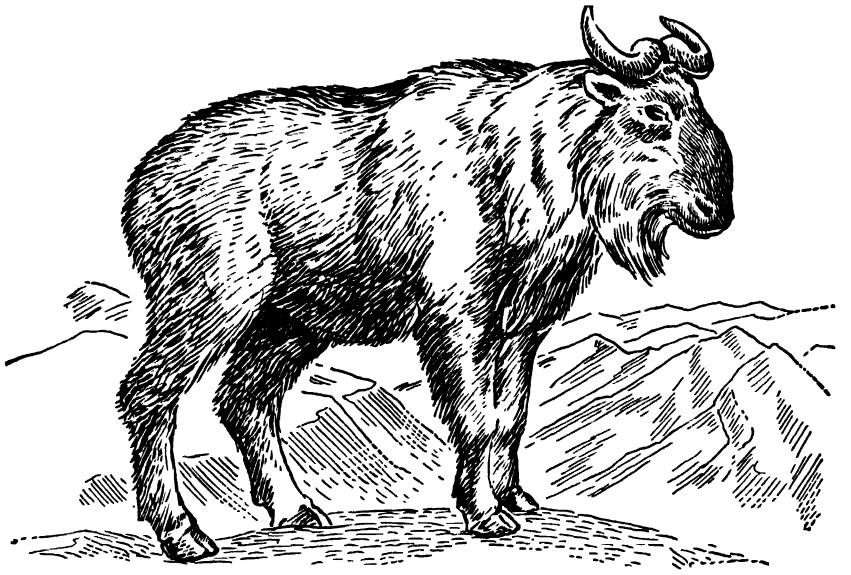
Though the typical chamois dwells in the Alps, local varieties range west over the Apennines and east through the Carpathians and the northern parts of the Balkan peninsula to the Caucasus and Asia Minor.

THE TAKIN–A RARE ANIMAL

The Takin, *Budorcas taxicolor*, is a rare animal, and little known. Living in exceedingly rough mountainous country from Bhutan to southern Shensi province in China, at elevations of eight thousand to fourteen thousand feet, the takin makes elusive prey in the dense thickets of bamboo and brush that are its home.

The Takin's Habits. From hunters we get a few interesting facts about the takin's habits. A heavy, clumsy animal, with a shaggy coat of yellowish hair, it spends the daytime in the thickets of rhododendron and bamboo near timber line, leaving its shelter in the evening and early morning to graze on nearby grassy slopes. Breaking narrow trails through the bush, it follows them regularly to favorite feeding grounds and salt licks. To the Chinese, the animal is *yeh niu*, meaning "wild cattle." They trap the takin for its flesh, using dead falls, spear traps, and snares. When the natives approach a herd they do so with great caution, claiming that if one beast is wounded, the rest will charge the hunter, and that they may also charge without even this degree of provocation.

Very shy and secretive, the takin associates in small groups of two to eight. (A related species, the Golden Takin, travels in larger herds.) When alarmed, the takin gives a hoarse warning cough; but during the rut in July and August, bulls utter a loud bellow. The calves are born in March, and three days after birth they are able to follow their mother around.



SHYEST OF THE LOT

Least known of the goat antelopes is the takin. It lives in nearly impenetrable mountains, where steady rains and short supplies make tracking it down quite difficult. In addition, the takin is furtive, spending its days in dense thickets, well hidden from the eyes of man. Only a few specimens have ever been captured.

Seen from the side, the takin, with its curving horns, looks much like a wildebeest. It stands well over three feet at the shoulder, with front legs that are especially stout. A short face and thick muzzle are characteristic of the head, which the takin carries low, in oxlike fashion.

MUSK OXEN—GOAT ANTELOPES OF THE ARCTIC

The Musk Ox, Polar Ox, or Sheep Cow, *Ovibos moschatus,* a native of the barren wastes of the American Arctic, is not an ox at all, but a

near relative of the takin of eastern Asia and the chamois of Europe. Although its legs are short, this robust, shaggy beast can gallop along at a fair speed, and in fact travels faster than a man; however, a dog can easily overtake a musk ox.

Herds of twenty or thirty musk oxen, chiefly cows and calves, are by no means unusual. The musk ox is one of the few animals that will join forces to combat a common foe. It would be useless for the animals to attempt to scatter and run away from a pack of swift Arctic wolves; by uniting in a circle with the calves safely inside, the musk oxen present an impregnable front to the enemy. Still it is not always possible to maintain an unbroken defensive position; sometimes three or four bulls will charge in unison in an effort to smash an attack.

With its back to a cliff and its two-foot-long horns ready for action, a single musk ox can protect itself from a whole pack of dogs or wolves.

MAN VS. MUSK OX

Musk oxen often take to the water. The author once saw a herd of thirty musk oxen, including cows and many small calves, swim across a deep lake a mile wide near the Thelon River in the Canadian Northwest Territory. They entered the water of their own accord and, strangely enough, at a spot where the author's plane was parked.

On the other hand, an old bull that the author cornered on a narrow, elevated peninsula jutting out into the lake, turned to face him rather than jump fifteen feet down into the water. Repeatedly the beast rubbed his nose on his front feet just above the ankles. Somehow this action seemed to stimulate his courage.

When the author got within twenty feet of the animal, down went the creature's head for a determined charge. The writer had just a split second in which to leap over the edge, landing in the icy water himself—much to the amusement of his companions.

A HEAVY COAT FOR SUBZERO WEATHER

Somewhat resembling a shaggy domestic bull in appearance, the musk ox is clothed in long, flowing chocolate-brown hair that falls almost to the fetlocks. A thick growth of wool underlies the heavy

outer covering of hair and serves as an impenetrable blanket against subzero Arctic temperature. Broad-spreading main hoofs and well-developed side hoofs have hair between them to facilitate progress on slippery ice or frozen snow. The tail is small and almost lost in the long hair of the rump.



A CASE OF MISTAKEN IDENTITY

The musk ox is not an ox, nor does it have musk glands like the musk deer, whose secretion furnishes the foundation for certain perfumes. The animal is, rather, a goat antelope, with horns somewhat resembling the takin's. A musky odor does emanate from the animal during its rutting season, however, and its flesh has a musky flavor at this time.

Both sexes have horns—massive structures that cover the head like a shield. Broad at the base and arising close together on top of the head, the horns curve downward along the side of the face behind the eyes, then upward to a sharply tapered point. The adult male is larger than the female—he generally measures about four feet at the shoulder, and weighs from seven hundred to nine hundred pounds.

In its frigid homeland, the musk ox roams far beyond the northern timber line. Its range extends from the coastal regions of northern Greenland south to the Thelon River, in northeastern Canada, including the adjoining Arctic islands. There are three named geographical forms: the Black-faced Musk Ox, the Hudson Bay Musk Ox, and the White-faced Musk Ox. The animal was once much preyed upon by the Eskimos, but now enioys protection in Canada.

MUSKY ODOR AT MATING TIME

The musk ox does not have specialized musk glands, but there is a noticeably musky odor about the animal during the rutting season, and the flesh has a decidedly musky taste.

Mating takes place between July and September, probably from late July into early August. Although the calves are usually born about May, some come as late as July and others early in March. One calf at a time is common, although occasionally twins are born. A newborn calf stands eighteen inches at the shoulder and weighs sixteen pounds.

The musk ox feeds on grass, moss, and any other edible plants, including shoots of willows and even branches of scrub pine trees. In summer, luxuriant grass grows knee deep on the barrens. Food is plentiful, and the musk ox waxes fat and contented, but in wintertime it must dig out a sparse livelihood of mosses and dead grass from under the driven snow.

Goats and Sheep in the Wild

It is not always an easy matter to tell the goats from the sheep, in the wild. Both are mountain folk, dwelling in the high places of the earth. Both are chewers of the cud, wear hairy coats, and possess hollow horns. But, although we may occasionally confuse a number of these creatures, there are some marked ways in which sheep and goats differ.

The wild goat is generally a more sure-footed and adventurous animal than the wild sheep. It can live off the coarsest of food. Although it may browse and graze on grassy slopes, it will, after eating, retreat

to a high crag for safety and slumber. The goat's horns are directed backward and upward, while the sheep's horns are usually spirally curved. Most male goats have a distinct beard and a strong goaty odor. Both sheep and goats were domesticated before 3,000 B.C., and probably much earlier than cattle.

Wild goats are restricted to Europe, Central Asia, and North Africa. We find the wild sheep in the Northern Hemisphere, including North Africa. (Goats and sheep form a subfamily of the Bovidae.) The Rocky Mountain Bighorn Sheep, the most spectacular animal of the American group, is not entirely a creature of the New World; close relatives do occur in Siberia.

YIELD OF THE GOATS: MILK, MEAT, AND MOHAIR

Goats produce milk, butter, cheese, and flesh for food, and they have been doing so for a long time. There are many mentions of the goat in the Bible. Job's he-goats are said to have been so strong that they could overpower wolves, while some carried bears on their horns. The water and wine containers mentioned in the Bible were made of goatskin.

In Palestine the goats were driven daily to market and milked at the door of prospective customers. They were much used in sacrifices and feasts; even today, when an Arab chieftain receives a guest, a kid is immediately killed and prepared for serving.

Like the wool of the sheep, goat hair is used for clothing. It is from Angora goats that we get the famous mohair. Reluctant though the Turks were to part with their monopoly of this species, it is now bred extensively in South Africa and Australia, where it produces an even finer grade of mohair than it did at home.

The cashmere goat is famed the world over for its fine fleece; a short-legged, graceful but frugal creature able to subsist on little food, the cashmere goat originally was a native of the Vale of Kashmir and the forbidding mountain ranges of the impenetrable Himalayas. Cashmere, the famous cloth, and shawls made from it, were prized as far back as the time of the Roman Caesars. This rare yarn of Kashmir was once only for kings and their courts. Today little cashmere wool actually comes from Kashmir—most of the better grades are products of China, Mongolia, and Tibet. It is combed out of the animal's coat.

SOME IMPORTANT WILD GOATS

THE TYPICAL BEARDED IBEX

Agile and Sure Footed. The Ibex, *Capra,* a native of Asia, North Africa, and Europe, is a common wild goat of the Old World. It dwells in the vicinity of precipitous cliffs and mountain crags at high elevations close to the snow line at all seasons of the year. Even in winter it does not resort to the shelter of timber; instead, it haunts steep hillsides where the snow is not deep.



A STURDY GOAT WITH FINE CURVED HORNS

Of all the wild goats, the ibex is probably the most familiar. This animal has almost disappeared in the Alps, where it once was fairly common; only a few small herds survive under the protection of the Italian government. The ibex may be tamed, and one species in Asia is said to be the ancestor of our domestic goat.

The ibex has acute senses of sight, hearing, and smell. Usually one animal seems to act as a lone sentry, keeping watch for possible danger; it utters a shrill warning whistle to alert its fellows at the slightest suspicion of anything untoward. Extremely agile and sure footed,

the ibex can leap down a forty-foot precipice to a rocky ledge below with perfect control and almost insufferable calmness. Wild dogs and snow leopards are common enemies of this animal in the Himalayas.

Mating Time. October is the mating season, when the males descend from their lofty pinnacles and join the females. Both sexes herd together at this time of the year but disperse when the snow melts in the spring. The males retreat to the more inaccessible mountain crests, while the females remain behind to give birth to their one or two offspring during May or June.

What the Ibex Looks Like. The ibex is the typical bearded goat. Its enormous horns (they measure up to fifty-eight inches) rise close together on top of the head and sweep back in a wide, even arc, like the blade of a scimitar. In the true ibex the horns are heavily corrugated on the broad front. The animal has a coat of rather long loose hair, usually yellowish brown in color.

Among the many kinds of these hardy animals, the Siberian Ibex, *Capra sibirica,* is the largest and most handsome; it is native to the mountains of central Asia, the Tien Shan, Altai, and the Himalayas. The Abyssinian Ibex is a stocky, heavily built species with short, stout horns, while the Nubian Ibex from upper Egypt, Arabia, Palestine, and upper Nubia can be recognized by its long, slender horns.

The European Ibex or Steinbok is now extinct in the wild. It formerly ranged in the higher Alps of Switzerland, Savoy and the Tyrol. A few still survive under protection on the Italian side of Monte Rosa. This animal is easily tamed but remains forever capricious—a word, we might remember, that was originally applied to the goat.

ANCESTOR OF OUR DOMESTIC GOATS

The Chetan Ibex, Pasang, or Wild Goat, *Capra hircus,* is the source of bezoar, once famous as a reputed antidote for poison. To this day bezoar is still regarded in Iran as a remedy for many diseases. The substance is secreted in the stomach of the pasang, which is why the great systematizer Linnaeus called this goat *Capra bezoartica.*

Bezoar balls are found in the stomachs of other animals, especially those that lick their coats—cattle and gazelles, for example. A bezoar ball is usually round, and smaller than a golf ball. Generally a formation of lime and magnesium phosphate around some foreign sub-

stance, it often consists entirely of hair or vegetable fiber. Sometimes it is used as a pigment.

The domestic goat is a lineal descendant of the pasang, which roams in herds over barren, rocky hills. The pasang has the peculiar habit of selecting the narrowest of pinnacles on which to balance itself. This goat dwells in a territory that ranges from southeastern Europe to southwestern Asia, and includes the neighboring islands.

The Spanish Wild Goat, *Capra pyrenaica,* used to be found throughout the mountains of the Iberian peninsula and is still plentiful in some parts of its former range. It is often referred to as the Pyrenean Ibex. The horns are of the wild goat type, compressed and having a sharp inner edge in front instead of being broad and knotty as are those of the ibex.

LINK BETWEEN GOATS AND SHEEP

The Eastern Tur, or Caucasian Bharal, *Capra caucasica,* is a robust and handsome wild goat with comparatively smooth, short horns which curve outward and backward close to the neck. One form, Pallas's Tur, which also lives in the Caucasus Mountains, is closely related to the Asiatic Blue Sheep, or Himalayan Bharal, mentioned later. Thus Pallas's tur is in effect a connecting link between the sheep and the goats, but it is a goat and not a sheep.

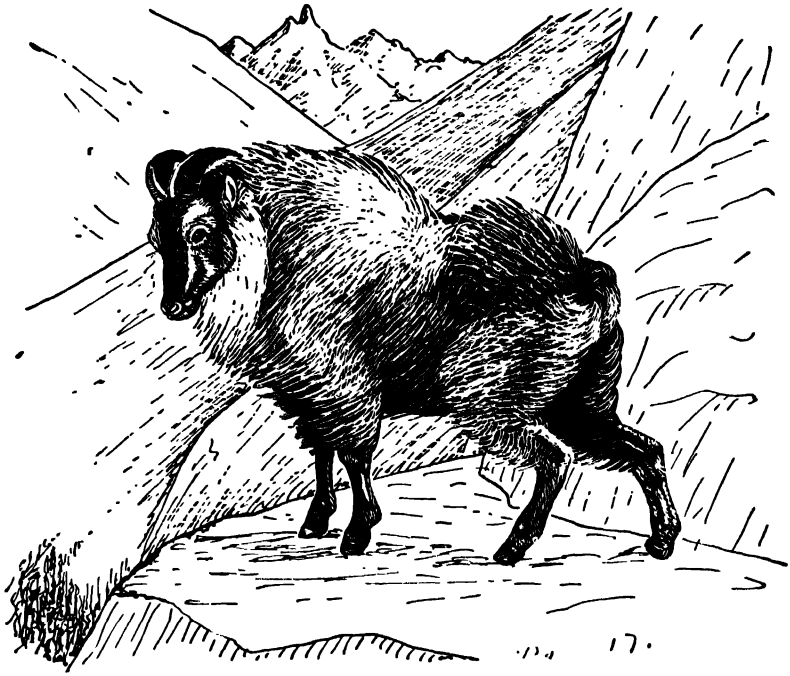
The Western Tur, native to the western half of the main Caucasian range, while still a wild goat, has heavy bosses in front of the horns like a true ibex, but the horns are shorter, heavier and not so evenly arched. The turs like to spend their time on lofty precipices above the snow line.

BEARDLESS GOATS

The Himalayan Tahr, *Hemitragus jemlaicus,* is a beardless goat with short, evenly curved horns, that lives at high elevations in the Himalayas. Here it runs in herds of five to about twenty-five, among the crags and rocky precipices near the timber line; old males may even enter thick timber. The tahrs are wary, sharp sighted and, like all goats, nimble on a steep terrain.

Though the Himalayan tahr is rather sociable, the sexes normally

live apart except during the mating season. Six months after mating, the female produces one kid. Other kinds of tahr dwell in the hills of southern India and southeastern Arabia.



DWELLER ON THE WIND-SWEPT HEIGHTS

With its short horns and beardless chin, the Himalayan tahr is rather unlike most other wild goats. At home in inaccessible mountain regions, it is a difficult animal to find and shoot. The Indians prize the tahr for its bones, which they use to treat rheumatism.

MARKHORS—GOATS WITH PATRIARCHAL BEARDS

The Markhor, *Capra falconeri,* has long, shaggy hair, and in old males the beard extends from the chin down the underside of the throat. This wild goat follows along the margin between deep forest and higher snow-capped peaks where the tumbled rocks and steep cliffs are hidden by the last stand of woodland growth. It rarely comes out on open mountain slopes or bare crags above the timber line.

The domain of the markhor extends from Kashmir in India through Baluchistan to Afghanistan. There are five named forms, in-

cluding the Astor Markhor and Punjab Markhor, that have long, spirally twisted horns. Famed as a hunter's trophy, they come out close together on top of the head and may curl in a wide, open spiral



ITS HORNS MAKE A REMARKABLE TROPHY

The markhor is a handsome wild goat, grayish brown to white in color and crowned with massive twisting horns. It has a long mane, and its beard almost reaches its knees. This superb animal, found from Kashmir to Afghanistan, is sometimes described as the "king of the wild goats"; the Persians named it markhor, which means "snake-eater."

like a corkscrew or straight with two keels winding round and round like a screw. The Himalayan Markhor is the biggest of the wild goats —it may stand over forty inches high and weigh more than two hundred pounds.

FAMOUS BREEDS OF DOMESTIC SHEEP

There is a vast difference between wild sheep and the forty breeds of domestic sheep. The domestic sheep have a long tail and a woolly fleece, whereas the wild varieties have a short tail and a stiff, hairy coat. It was man's selective breeding that made the sheep the valu-

able wool-bearer it is today. Most authorities are agreed that the domestic sheep was derived from the Red Sheep, *Ovis orientalis.*

A FORTY-POUND TAIL

Sheep are the chief wealth of the pastoral tribes of Asia. In Turkestan the nomad Kirghiz live almost entirely on mutton. They have developed a variety of sheep known as the Dumba, which has an excess of fat on the buttocks. This breed possesses a long, fat tail that may weigh up to forty pounds. In Tashkent the author saw a prize-winning specimen that carried its huge tail in a little cart harnessed to the sheep. The Kirghiz not only eat the mutton but use the wool for clothing and beat it into heavy felt for covering their yurts, or tents.

MERINO AND PERSIAN LAMB

The Merino Sheep of Spain is famous for its wool; often it is so thick that it covers the animal's eyes. The Spaniards introduced the merino into America at an early date, and it has also found a good home in Australia. This hardy, sociable animal is said to produce more and finer wool than any other sheep. Its mutton, however, is not highly esteemed.

It is from the Caracul or Karacul that we get the Persian lamb or broadtail, originally referred to as Astrakhan. The best pelts are taken from caracul lambs when they are between a week and ten days old, for then the curl is at its best. Black pelts are the most desirable. These sturdy animals are at home in semiarid regions—particularly in Bokhara, in the Uzbek republic of the Soviet Union.

A good deal of Australia's prosperity today is based on the raising of sheep. Western Asia and the western part of the United States are also responsible for much of the world's wool. Britain, too, is a famed breeder of sheep for wool and mutton; the Cheviot Sheep of Scotland, Southdown Sheep, and Shropshire Sheep are three noted British breeds.

SHEEP IN BIBLICAL TIMES

No other animal gets as much notice in the Bible as the sheep. This animal played an important part in the religious, civil, and domestic

life of the ancient Hebrews. As for the nomadic Arabs, they are just as dependent on their sheep today as they were in Biblical times. They must still travel to suit the convenience of the animals; the Arabs cannot stay in one locality longer than the pasturage will support the flocks.

In ancient times sheep were tended more carefully than we think. The thought of obtaining water for his flock was uppermost in the shepherd's mind. Rarely, if at all, did sheep die of thirst—even when crossing large deserts which lacked surface water. The shepherd knew the hidden wells. His solicitous care has been immortalized in the forcible imagery of David, the shepherd poet: "The Lord is my shepherd; I shall not want. He maketh me to lie down in green pastures; He leadeth me beside the still waters."

The sheep were always watered at noon—never earlier or later in the day. The shepherd knew all his sheep by name and did not need to drive them. Sheep were kept more for their milk than their flesh. (Today our main product from the milk of these animals is Roquefort cheese, originally made in France.)

Sacred Trumpets. The horn of the ram had a special value for the ancient Hebrews; from it was made the sacred trumpet—the *shofar.* Mosaic law required these horns to be sounded on certain religious occasions. Each jubilee year was ushered in by the blasts of the sacred trumpets. The walls of Jericho fell, so the Scriptures tell us, when the trumpets of rams' horns were blown on the seventh day.

The Sacrificial Lamb. The sheep was important above all as a sacrifice. Mosaic law specified the age and sex of the sheep to be used. A young male lamb was the usual sacrifice.

The basic rite was the sacrifice of the Paschal lamb, the precursor of Christianity's Lamb of God, which taketh away the sins of the world. The lamb was killed for the feast of the Passover, and the blood was sprinkled with hyssop on the altar. Its flesh was eaten in haste; whatever was left, was consumed by fire.

A SPECTACULAR SHEEP

The Rocky Mountain Bighorn Sheep, *Ovis canadensis,* does not conform to our conventional notions about sheep. There are several

kinds of bighorns, but this is the typical bighorn, the best known, the largest, and the one with the widest distribution.

Some authorities consider the Rocky Mountain bighorn America's finest game animal. At that, the bighorn would not have much to fear from the average sportsman if it were not for the telescopic sights and supercharged ammunition of the modern high-power rifle. The bighorn has extremely sharp eyesight and long-range vision. Its sense of smell is exceptionally acute. Its ears are attuned to catch the faintest sound.

HOW THE BIGHORN NEGOTIATES CRAGS AND CLIFFS

Though goats are excellent climbers, they by no means match the bounding swiftness of bighorn sheep. The feet of the bighorn are equipped with soft elastic pads that absorb the shocks of a bouncing gait and also provide an effective grip on hard, rough, or slippery surfaces.

Sailing Off into Space. There are few cliffs that bighorns cannot surmount—not carefully and step by step like a mountain goat, but at a seemingly heedless and breakneck gallop. Observers have watched these sheep careening down precipitous cliffs, leaping twenty feet at a time and breaking their speed by bouncing without hesitation from one narrow ledge of rock to another. Near the bottom of the cliff they sail off into the air with a final majestic bound, to alight on all four feet on the floor of the valley.

Occasionally a bighorn does crash to its death in one of these magnificent charges, but it is usually the ram and not the ewe that dies this way. Barring fatal accidents and the possibility of being killed by wolves or bears, the bighorn can look forward to a long, happy life on the sunlit mountain tops. The average mountain sheep has passed its prime at ten or twelve years of age and is old at sixteen; under very favorable conditions, it may live to the grand old age of twenty years. But this is exceptional.

BATTERING RAMS

Francisco Coronado, the famous Spanish explorer of the American Southwest, was the first white man to see the bighorn. He alluded

to the animal in a letter, dated August 3, 1540, to the governor of Mexico, describing it as a sheep as big as a horse with large horns that were something to marvel at.

Actually, a full-grown bighorn may average forty inches in shoulder height. Its weight may range from 175 to 350 pounds. The horns of mature rams often form more than one full turn, the record length being a trifle short of fifty inches. Ewes have smaller, compressed horns seldom exceeding fifteen inches in length.

The bighorn's summer coat is dark (or grayish) brown; its winter covering is lighter and grayer. The hair, like that of other wild sheep, is not woolly as in domestic sheep; instead, it is long, coarse, and full, like a deer's.

Mating Battles. Mountain sheep are herd animals, but the males and females do not mix except for a brief period in December during the mating season. At this time the rams vie fiercely with each other for possession of the ewes. They indulge in none of the pre-battle antics typical of moose, or other horned beasts; they do not trumpet defiance at each other or roar challenging cries to combat. Instead, they settle down to serious fighting with little preliminary skirmishing.

Almost like professional boxers, two antagonists size up each other critically; then, after backing off a hundred feet or so, they charge headlong at about twenty miles per hour, crashing together in a smashing impact that can be heard two miles away on a still day. Again and again they repeat the battering onslaughts, until superior strength and endurance determine the ultimate victor.

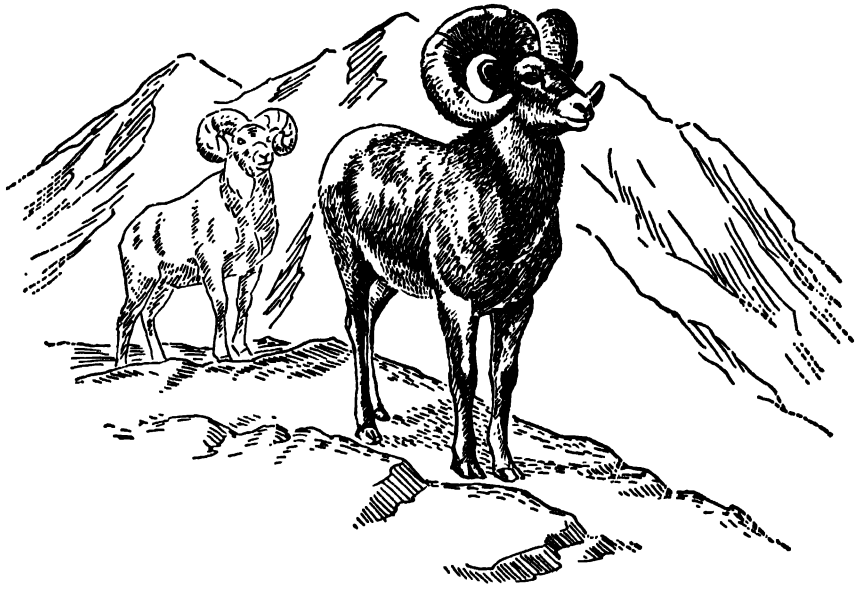
GRANDMOTHER KNOWS BEST

By January the mating season is over, and the rams calmly resume their bachelor ways; even though they meet a flock of ewes, the males now pass them by indifferently, preferring the companionship of their own sex.

The lambs, usually two to a female, are born in late May or June. At first the mothers hide them and lick them; "owning" the lamb, as it is called, is a ritual never omitted. Before the day is out, the young are skipping about, following their mother, and are soon ready to join the herd.

The ewes and their yearling lambs associate in small flocks rarely

numbering more than twenty head. The herd leader is a wise, portly ewe, the grandmother of much of the flock but still young enough to bear offspring annually. She keeps constant watch over her charges, since the safety of the entire group depends on her judgment and guidance.



AN ANIMAL WELL NAMED

The bighorn sheep, with its great, curling horns, is a creature easy to recognize. Although its coat is hairy rather than woolly, the animal is a true sheep all the same. Bighorns are silent as a rule, but occasionally they will emit a loud snort.

A DELICATE EATER

The bighorn is rather particular about its food and eats nothing but sweet, fresh mountain grasses and flowers; it rarely, if ever, browses on shrubs. All summer long the bighorn grazes in the upland meadows and grassy hillsides above the timber line. When the vegetation gets sparse and thin, the rams go a little higher to the edge of the rocky crags.

In the winter there is a general movement toward the shelter of the timber and the lower valleys. The bighorn, however, keeps to its own familiar territory or home range, where it knows all the trails and lush feeding grounds.

Some mountain sheep live in sun-baked sandy wastes, and they are thought to be able to get along without water; in fact, some authors go so far as to claim that these desert-loving sheep never drink. The chances are, though, that the sheep know of a secret waterhole to visit, though they may have to travel twenty miles to get a drink. They no doubt get considerable plant juices from the fat cactus leaves.

Aside from the typical bighorn, there are nine geographical varieties, including the Desert Bighorns and the Badlands Bighorn. They range from southern British Columbia to northwestern Chihuahua, Mexico, and are also found in eastern Siberia.

RELATIVES OF THE BIGHORN

Fantastic Climbers. In northern British Columbia the author once came upon twenty-five big rams. They were Stone's Sheep, *Ovis dalli stonei,* and they were resting on a little hill surrounded by a huge natural amphitheater. It seemed to the author that he had them cornered—unbroken walls of rock rose straight up two thousand feet on all sides, except for the entrance.

Unnoticed was a fold in the face of the cliff forming nothing more than an angle; up this the twenty-five rams went unhesitatingly in quick succession, bouncing back and forth like rubber balls. Higher and higher they went, and finally the last one was over the top. A pause of even a fraction of a second in that stupendous climb would have meant certain death on the ragged rocks below.

Stone's sheep, also known as the blue sheep or black sheep (it is deep gray to blackish brown in color), dwells in British Columbia. It has a close relative in the White Sheep, or Dall's Sheep, *Ovis dalli dalli.*

Encounter in the Wild. With the exception of man, few enemies endanger the life of the white sheep, an animal that closely resembles the Rocky Mountain bighorn but for its white, or yellowish-white, color. Wolves and lynxes are swift enough to menace mature sheep, but only seldom do they succeed in making a meal of them.

On one occasion, Charles Sheldon, a noted observer of Alaskan game, noticed some sheep behaving strangely on the north side of the Alaska Range. He says: "I soon saw on the ground, at the foot of the slope, a sheep apparently dead, with a bloody head. Then im-

mediately a lynx was looking at me. It quickly ran up the creek a short distance and disappeared in the rocks. Following rapidly, I saw it sitting on a ledge and shot it. Bringing it back to the sheep, I found that it had just pulled the sheep down the slope. I had missed seeing it by a minute only.

"The snow revealed part of the story. The lynx had waited on a rock about 500 feet up, and, as the ram (about two years old) crossed the slide, the lynx sprang on its back, and fastened its teeth in the left eye. Together they came down the slide, and at the bottom a struggle ensued. The lynx lost its hold and fastened again to the right eye. Not another tooth mark was on the sheep."

Though the white sheep is the smallest of American wild sheep (it stands a little over three feet at the shoulder), its record horn length is forty-seven and one-half inches. This sheep dwells in the mountains of Alaska and the northwestern part of Canada.

THE LARGEST LIVING SHEEP

The Ammon, or Argali, *Ovis ammon,* the largest of all living wild sheep, lives on the highlands of central Asia, from Bokhara to Mongolia and Kamchatka. Here it is at home on grassy hillsides and meadows above the timber line. An agile mountain-climber, the argali can travel faster than any of the goats over precipitous crags and rugged mountain peaks.

The argali may attain a shoulder height of four feet and a weight of 350 pounds. The horns of the rams are large and massive, curling outward from the side of the head and frequently making more than one complete turn.

A FIND OF MARCO POLO'S

In the thirteenth century, the famous Venetian traveler Marco Polo first discovered the magnificent Pamir Argali, also known as Marco Polo's Sheep. However, this animal remained practically unknown to western science until specimens were obtained for the British Museum in 1874. The comparatively slender but still massive horns of Marco Polo's sheep curve sharply away from the head, forming more than one complete turn that may measure seventy-five inches along the outside edge.

ABOVE THE CLOUDS

Marco Polo's sheep is reported as living in herds, often of considerable size, on the Pamir plateau of southern central Asia. These herds resort to the most inaccessible and difficult mountain ranges at elevations of ten to twelve thousand feet, where the age-worn shale slides and there is a total absence of cover. After days of hard going in the rarefied air of this remote and secluded retreat, which is without trails and remains unmapped to this day, one may have the satisfaction of viewing the "heraldic beast of central Asia."

At first one sees nothing but the great curling horns, but they are attached to a giant ram that has found himself an impregnable position on top of some isolated grassy knoll. Though he may be a battle-scarred old warrior retired to a lonely but peaceful existence away from the herd, and may even be drowsing in the sunshine, he will quickly leap out of sight at the first sign of danger and will not pause until he has passed on to the next mountain range.

There are twelve geographical races of Argali, including the Littledale Sheep of the Tien Shan.

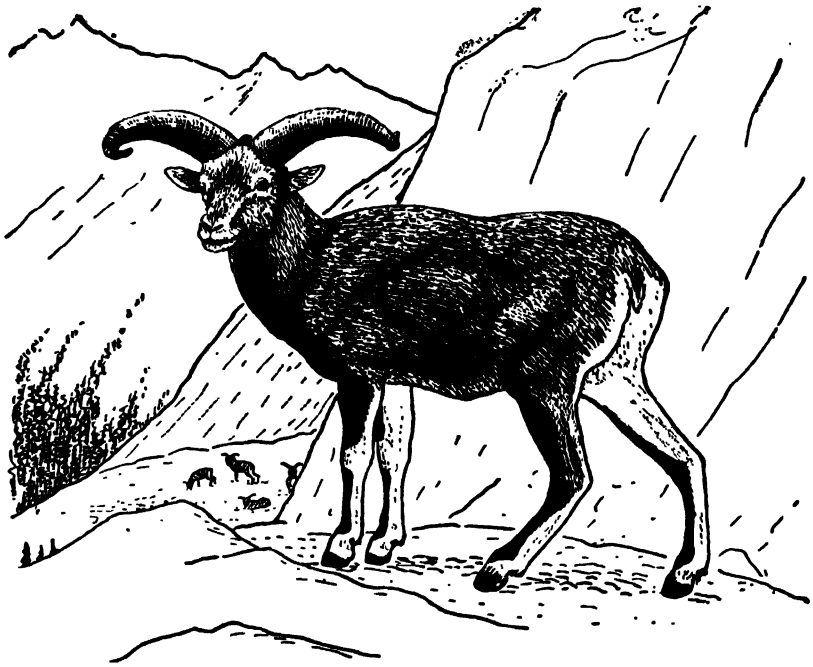
OTHER INTERESTING WILD SHEEP

The Himalayan Bharal, or Blue Sheep, *Pseudois nayaur,* while definitely not a goat, has the markings and horns of one, though it lacks the strong, disagreeable odor of the typical goat. The blue sheep dwells among the heights of the mountain ranges of central Asia from Tibet to western China. In summer it may be found at elevations of seventeen thousand feet, and even in winter it probably never descends below ten thousand feet.

Blue sheep gather in flocks of eight to more than fifty. Watchful and wary animals, they take, or at least seem to take, the precaution of stationing a sentry on a high point amid the jagged rocks, while the rest of the herd feeds on grassy slopes high above the timber line. The sentinel remains motionless, almost invisible in its surroundings, until some suspicious occurrence sends it bounding from its post. The herd immediately races to refuge among steep crags, which they prefer to seeking shelter in the neighboring bush.

The sexes always live separately except during the breeding season. After mating, the rams leave the ewes in June or July. The lambs

are born one hundred and sixty days later. Twins are not uncommon, and the young are not weaned until fully three-quarters grown. There are two local races, the Chinese Bharal and the Kansu Bharal.



FAMED BLUE SHEEP OF THE HIMALAYAS

The bharal, with its down-curving horns, is one of the common wild sheep of the mountains of central Asia. In its lofty homeland it is a most difficult animal to hunt, but its mutton is said to be excellent. The bharal is easy to domesticate. Sheep, in general, are less capricious and adventuresome than goats.

The Aoudad, or Barbary Sheep, *Ammotragus lervia,* is also known as the Udad, Audad, Arui, Fechstal, and Maned Sheep. It is the only wild sheep found in Africa and may be recognized by its uniform tawny color and the fringe of long hair hanging from its throat, chest, and the upper parts of its forelegs. It has a longer tail than other wild sheep. There are seven varieties of aoudad. The animal stands over three feet at the shoulder, and its horns may be thirty inches long.

This big sheep lives in small family groups, except for the rams, which are more or less solitary except for the breeding season. The animal is at home in the Atlas Mountains and the Aures that fringe

the Sahara Desert. It often is seen on isolated outcrops of rock that jut out of the burning desert and even on arid, level ground almost destitute of vegetation and water.



THE BIG BARBARY SHEEP

A stately-looking creature indeed is the ram pictured above—the aoudad, or Barbary sheep. Standing amidst the rocky crags of the North African mountains, where it lives, often the animal can hardly be seen, unless it chances to be silhouetted against the sky.

The Mouflon, *Ovis musimon,* is one of the very few wild sheep in Europe. It is a native of the mountains of Sardinia and Corsica, but has been introduced into Hungary, Austria, Czechoslovakia, and other countries. It is a rather small species, reddish brown in color with a whitish saddle in winter. The ewes usually, but not always, have horns.

The Red Sheep, or Gmelin's Sheep, *Ovis orientalis,* is yellow or fox-red in summer and brownish in winter, with a gray saddle patch. The horns are not unlike those of the mouflon, but usually curve more

sharply backward and terminate behind the head. There are several species of red sheep that inhabit the arid rocky mountain ridges of Asia Minor, Transcaucasia, Persia and Cyprus.

The Urial, Gad or Shapo, *Ovis vignei,* is also known as the Oorial or Sha. It has an extensive range and is spread over the mountains of northwest India through Afghanistan to Transcaspia, Turkestan, and Russia. This is a variously colored sheep but usually it is reddish brown. The males have long, slender horns that form a large, open curl.

While it is generally conceded that most of our domestic sheep were derived from the red sheep, the mouflon and the urial can not be entirely excluded as possible ancestors.

Evolution and the Story of Animal Life

Scientists tell us that our earth came into being some three billion years ago. The infant planet, when it became separated from its mother, the sun, was a mass of blazing gas, much as Old Sol is today. In time—and it was a very long time—this gas cooled and turned solid. Rocks began to form.

Some of our rocks are now calculated to be nearly two billion years old. It is possible that life on earth extends almost back to the age of these rocks! These figures, it is true, are staggering, but they are finite and something that we can understand.

How did life begin? That is a question that has fascinated man ever since he became a thinking creature. In our own days, we have found a reasonable answer, and doubtless we shall be able to prove its accuracy before long.

It appears that sometime during the first two billion years or so

of our planet's history the spark of life was born. A combination of materials and conditions came together and spontaneously produced this novel element on earth. It probably began as the result of the wearing down and rotting of mineral and rocks, which released certain chemical elements; the radiant energy provided by the rays of sunlight may well have played a part.

LIFE BEGINS IN THE WATER

The birthplace of life, most scientists are convinced, was in the water. Even today all living things must have water in some form to survive. No creature can breathe air or digest its food without water. Where species of animal life have been traced back to primitive types, the trail always leads to the water. The oldest known fossils, dating back five hundred million years, are of marine origin.

Where air, water, and land come together, there is and always has been a theater of great activity. It was in the land waters or inland seas, rather than the primitive oceans, that life must have started. It had its beginning, we believe, where the tides flowed and receded over warm mud and ooze or steaming beaches of hot sand.

When our planet was young, the atmosphere was heavy with moisture, and warm rain almost incessantly poured down on the hot earth. The sun blazed on an unshaded land and set in a quarter of the time it takes today. Particles of organic compounds were formed in this setting, and they took on a living individuality. They fed and grew, and were capable of motion. It was these strange new things on earth that started the endless chain of dying and being born again.

Of these earliest forms of life we know little or nothing. They must have been simple, one-celled, virus-like molecules, so minute in size that they could not be seen through our most powerful microscope. These molecules were more vegetable than animal, but they came before either.

LIFE FROM NOT-LIFE

How could life come from not-life, you may wonder. Is all this a romantic conception? Such hardly seems to be the case. The basic substances that make up our earth are the same substances we find within our bodies.

Eminent scientists like Dr. Harold C. Urey, the great American

physicist who won the Nobel Prize, have theorized that life came into being when methane (marsh gas), hydrogen, and certain other factors met. One of Dr. Urey's students has supplied good support for this hypothesis. The scientific world was recently startled to learn that this man had brought these constituents together under appropriate conditions in a laboratory and produced amino-acids, which are the building-blocks of all living matter. We may not be so far away from creating living tissue itself.

THE FIRST LIVING THINGS

For the first live molecule to develop into a tiny, one-celled animal the size of the amoeba, which is visible under the microscope, untold aeons of time were required. The span of years was considerably greater than that taken for the first one-celled animal to evolve into an elephant or a man.

More than three-quarters of the earth's history had already passed before the one-celled jelly-like plant-animals, the Protozoa, the earliest *known* forms of life, appeared. They were much the same as living forms of today. Some had supporting body structures; often they were very beautiful. Contemporary with the early forms of animal life was the archaic vegetable matter, later the lower vegetation, and on to the higher plants.

As vegetation progressed, so the animal life evolved. One depended on the other; at least animal life was dependent on vegetation for its starches and proteins, as it still is today.

The very simplest forms of life left no records. It was not until living things had acquired a supporting structure like a skeleton or a shell that vestiges of their existence could be preserved or fossilized in tablets of rock. All the pages of the earth's rock diary have not yet been opened, but in the ones already available we may read the rough outlines of the story of how simple one-celled microscopic forms of primitive life developed into the highly specialized animals of the present day.

OUT OF THE WATER AND ONTO DRY LAND

At first life had to keep close to the shallow shore water. It was dependent on air dissolved in water, and sunlight. It faced the constant danger of being stranded.

One essential characteristic of life is changeability. Living matter is unstable, and these first living things changed in many ways and branched out in many directions. After a while there were water animals with backbones. Where there had been only invertebrates to begin with, now vertebrates also existed. The fishes came into being.

So now we have fairly well-developed animals in the water, but none on land.

Before living creatures could leave the water with impunity, they had to acquire a suitable breathing apparatus. A fish, taken out of the water, does not immediately die from lack of water but because its gills dry up and it cannot breathe. This was the problem, and before it could be solved some of the water animals had to change still further. In time they did. They developed lungs of a sort, and circumstances obliged the animals to use them out of water.

The fishes, as such, stayed in the water. But from their stock there had developed some whose large, strong fins could serve as legs. These animals were either stranded or else they crawled from the mud onto dry land. They became primitive amphibians—animals that may live on land but generally deposit their eggs in water, as their finny forefathers did. The ancient amphibians became the ancestors of the reptiles, birds, and mammals of yesterday and today.

The life cycle of the frog, an amphibian, shows the principle of liberation from the water—but incomplete liberation. The female lays her eggs in the water. From these, in a short while, tadpoles develop. The tadpole has gills to breathe air dissolved in the water, and feeds on minute vegetable matter.

Early in life, the tadpole is little more than a head and a tail. But later the tadpole grows hind legs and then fore legs and then lungs —the equipment of a land animal—and loses its tail and gills. The creature is now a frog, and can leave the water to live in the air and feed on animal matter. When it wants to breed, however, it must return to the water to lay its eggs, for they need moisture, in order to develop.

THE INSECTS GO THEIR OWN WAY

The insects and their close relatives had a parallel development. Insects came of a stock derived from primitive forms (the trilobite is an example) that lived in the land waters and became amphibious.

In the earliest stages they were wingless—much like the "silverfish" we find in bathrooms today. The first insects of which we have a record show up with well-developed wings in deposits laid down in the early Carboniferous period, three hundred million years ago. Insects were capable of flight fifty million years before the reptiles and the birds.

The size of the ancient insects was truly amazing; at no other time in the history of the earth have they grown so large. There were carnivorous dragonflies that had a wingspread of twenty-nine inches. Many of the insects of today reflect their amphibious origin; like our frogs, they spend the early part of their lives in the water.

EVOLUTION AND THE STRUGGLE FOR SURVIVAL

A million kinds of animals exist in the world today (three-fourths of this number are insects). Of the many millions of creatures in each species no two are exactly alike—in fact, no two organisms or parts of an organism are precisely alike—no matter how closely related. Some species of fish, the ling for example, may produce twenty-eight million eggs at a time but no two of the progeny are exactly the same. Some forms of life multiply at the rate of six hundred generations in a year.

The essential factor behind evolution is the teeming abundance of life from which to draw. In general, reproduction of life is far in excess of the numbers that can possibly survive. Each animal has to face keen competition—it has a host of rivals for the existing food supply. Of the many millions of animals born each year, only a relative few live to reach maturity and the breeding stage.

Those that survive in the long run do so because they were born with some slight difference—some advantage over their fellow beings. This is the starting point of what is called "natural selection" or "survival of the fittest," a concept identified with the name of Charles Darwin.

ONLY THE FIT SHALL LIVE

What sort of advantages make a creature better fitted than its fellows to cope with the conditions of existence? The variation in the animal may be fractional, perhaps only just a shade in color that

blends more perfectly with its surroundings than do the hues of the rest of its kind. It is just that small advantage that permits one animal to survive while the others must perish. Or the survivor may be bigger or faster. It may have a longer neck and longer legs, and be able to get at food which is higher up on a tree—food that its brothers and sisters cannot reach.

Each animal puts to the best use its own advantages and abilities in its efforts to survive. Within a given species, this might appear to be competitive rivalry. But it is hardly a vicious contest in the human sense. There is no malicious intent to harm; no hatred or enmity is involved. There is no plotting or willful exercise of cruelty, nor is there any love or sympathy meted out among the competitors.

Whatever an animal's inborn advantage is, it may on occasion be handed on to succeeding generations. The same thing happens to inborn disadvantages. If the disadvantages are great, however, the animal will not live long enough to breed.

Creatures with genuine strong points will continue to multiply, and the strong points will be emphasized in their descendants, as one better-equipped animal mates with another one like it. The longer neck, for example, becomes longer—so, too, do the legs—and we have the giraffe, which is a far cry from the short-legged, short-necked ancestral stock that begot it.

Take horses as another instance. The first horses on earth were very small creatures with four toes. They were not fast enough to escape the enemies that developed in time, nor big and strong enough to fight them. Larger horses, ultimately with one toe (the hoof) evolved, and were equipped for a successful existence. These are the horses we know today. The others became extinct ages ago.

THE MEANING OF RADIATION

All that has been written here is a simplification of what happened in the history of life. That history, in the main, is a process of radiation, and an enormously complicated one at that.

Radiation, if it is not already clear, may be easily explained. To begin with, we find a single kind of animal—we call this a species. Some of its descendants vary from it, and in a number of instances these variations become permanent (at least for a long while). The original stock goes on, if it is well adapted to its circumstances, and

so do the descendants. But they look less and less alike, and they cannot interbreed, as the generations mount up. (They have become different species.)

A later generation may change again, and become still more different from its ancestral type. This may go on ad infinitum. Some lines become extinct in time. Or the original stock, from which the first variations sprang, may produce still different forms after a long or short while.

The transformations of the species may be very great indeed. Not just new species are produced—entirely new classes of life may evolve. The sparrow on your lawn is a descendant of gliding and flying reptiles of perhaps a hundred million years ago—it is actually a cousin of the dinosaurs! Man himself is the latest offspring of small shrew-like mammals that cowered in the grass as the dinosaurs lumbered by and the first leathery-winged birds circled overhead. But a long line of gradually changing tree-dwellers—finally a race of large-bodied apelike creatures—had to evolve before the first man could spring from their loins.

AN ANIMAL'S SURROUNDINGS

Survival, in the final analysis, is always survival within a certain environment. The climate in a given region is never stable, but may change in the course of time from warm to cold or from dry to wet. The creature that through natural selection (the survival of the fittest) becomes adapted to conditions of intense cold may not survive a change to a warm climate. At one time, parts of the earth were covered with snow and ice. It happened that certain species developed long hairy coats, and were equipped to withstand the cold. These were such animals as the woolly mammoth and woolly rhinoceros. When the ice receded and disappeared, so did these woolly giants. Their relatives, the elephants and rhinoceroses pure and simple, have fared better.

There were many more species in past geological time than there are alive on the world today. Just think, for a moment, of the Age of Reptiles. The dinosaurs—"glorified reptiles" they have been called—existed in huge numbers and great variety long ages ago. They dominated the earth for millions of years when the climate was warm and moist. As times changed, the rich swamps and greenland in which

the dinosaurs had luxuriated ceased to exist; the dinosaurs were through. But minute shrewlike mammals, descended from the same reptile ancestors as the dinosaurs, did not have to fear the change. On the contrary, it did them good by removing their big competitors. Thus the Age of Mammals could begin.

THE DANGER OF BECOMING TOO SPECIALIZED

We have seen that animals are variable. Before birth, random changes occur in them, either slow or fast, and they become new kinds of animals. The variation in a species may enable it to meet the requirements for survival in an environment. But often, when an animal becomes very specialized—like the woolly mammoth or the dinosaur—marked changes in its environment may mean its doom. Some of the dinosaurs' contemporaries—the birds are an example—managed to go on because they were adapted to meet the new circumstances.

There are many animals that have changed little or not at all from the parent form through countless generations. (Oysters of today appear to be very similar to oysters that lived two hundred million years ago.) This does not imply that evolution has stopped in a particular form—that the creature has reached a state of "perfection." It might indicate that such an animal has acquired the features or qualities necessary to survive, and has successfully met the competition. If conditions changed, a new form or variation might be favored by them, and take the place of the old.

THE IMPORTANCE OF HEREDITY

Heredity is the channel through which the various forms of life are handed on. It is a conservative factor that enables a new form to proceed to its ultimate goal and to persist. In general, the variation of an individual must be handed down through generations before it can be properly developed and put to use. The horses passed through many stages before they reached the efficient form of the modern species. Just how variations become inheritable is one of the mysteries of evolution.

Changes arising from habits or accidents cannot be inherited. Scientists have tried cutting off the tail of mice through numerous genera-

tions, yet never have they succeeded in reducing the length of the tail in the last born.

The change in a species comes with variations that occur in the chromosomes, the heredity bearers within the animal. Although the chromosomes are usually fixed in number for each species, they are somewhat variable in the traits they embody; it is these variations that, when favored by natural conditions, enable a species to change and survive.

Not all of the changes within a species are outward, or physical. A creature's impulses may evolve and be passed on by heredity. Birds migrate by inherited impulse; insects are directed to certain flowers by it; a bee dances to tell its fellows where there is nectar to be found, and it knows how to perform this dance without ever having seen another bee.

Sociability is handed on by animals as a survival trait. Some animals can exist only if they live together in large colonies or flocks. When the huge flocks of passenger pigeons were reduced by human intervention to a few stragglers, they became extinct; the few left automatically disappeared, leaving no offspring.

DARWIN'S CONTRIBUTION

Relatively speaking, all of this is new knowledge. The theory of evolution is hardly one hundred years old, and, as is widely known, we trace it back to Charles Darwin, the great English biologist. Only in the light of Darwin's theory, first set forth in his book *The Origin of Species* (1859), can we understand the principle of radiation—why there are hundreds of species of rats, thousands of species of beetles, all alike and yet different. When Darwin appeared upon the scene, it was almost universally believed that species were immutable—that each one had been as it was since the beginning of time.

It is to Darwin's immortal credit that he was able to perceive what has since become so obvious. Through evolution he explained how amphibians developed into reptiles; how reptiles changed in one direction to become birds, and in another to become mammals. Recent investigators have discarded some of the details of Darwin's thought, but in its main outlines it is the only explanation accepted by the majority of scientists as to how all the forms of life, both animal and vegetable, came into being.

ANIMALS OLD AND NEW

To appreciate fully the highly specialized mammals of this modern age, we must consider the wonderful story of how they developed. That story, as already suggested, takes us back to the dim ages of prehistory.

The earliest of the great geological eras of our earth was the Archeozoic ("primitive life"), which is estimated to have started approximately two billion years ago. The earth, then, was perhaps already a billion years old. In the Archeozoic era, life is believed to have had its first beginnings. We have found fossil carbon in the rocks that were laid down at that time, indicating that some form of life existed—probably the very simple one-celled types of plants and animals discussed earlier.

During the second great era, the Proterozoic ("former life"), more complex living things developed from the simpler ones that had preceded them. Bacteria, seaweeds, sponges, and various other kinds of animals without backbones made their appearance and established themselves.

In the earliest period of the Paleozoic era ("ancient life"), the next major division of time, the shelled invertebrates were the dominant form of animal life, seaweeds the dominant plant life. Fishes, the first animals with backbones, appeared later. These were followed by the amphibians and the primitive reptiles. Ferns, horsetails, and related plants developed in great stretches of forests and swamps. (On the accompanying Geological Timetable of Animal Life you will see typical animals of the Permian, Pennsylvanian, Devonian, and other periods—spans of time which take their name from ancient rock strata.)

The Mesozoic ("middle life") was the Age of Reptiles. These animals completely dominated the waters of the earth, the lands, and the air. Dinosaurs and flying dragons abounded, while the birds and mammals made their first precarious beginnings, as did the true flowering plants.

THE AGE OF MAMMALS

It was not until a hundred million years later, in the Cenozoic ("recent life"), the fifth great era of geological time, that the mammals

rose above the ranks of the reptiles and amphibians to become the major power in the world. The Age of Mammals extends through to the present day. Opening more than sixty million years ago, it was divided into periods of great progress and long periods of transition when many of the common mammals disappeared and new forms developed.

Thousands, perhaps millions, of years elapsed between the close of one period and the rise of another. Even so, at these times there were many holdover species from the earlier animal life that continued on with the new. In some parts of the world the intermission between the periods appears to be marked by an abrupt beginning and ending, but elsewhere there was a continuity of progressive development of the mammals from the older periods to the new.

Time and again, the older and more primitive forms were replaced by new and more modern species, which for thousands of years flourished, multiplied, and enriched the earth. Then gradually a new fauna would arise. These major transitions were brought about by the evolution of the earth itself, the change in climatic conditions, and in part by restriction of habitat caused by the encroachment and recession of the seas.

The first major period in the Age of Mammals was the Eocene ("dawn of the new"), which lasted about thirty or thirty-five million years. At the beginning of this period (the first part is sometimes referred to as the Paleocene or "ancient new" period) the earth was populated with many strange primitive mammals: they were thickset, heavily built creatures with short legs. Toward the end of the Eocene there was considerable improvement. Many rhinoceros-like animals appeared, and along with them the four-toed horses.

The Oligocene ("a little new") lasted about ten million years and represented a great advance over the Eocene. It was an age of giants. There were many kinds of rhinoceroses, such as North America's great Titanotheres, *Baluchitherium*, which was fourteen feet high at the shoulder; giant pigs, three-toed horses, primitive flesh-eaters, and many other strange creatures abounded.

The next period, the Miocene ("less new"), lasted about ten million years and brought giraffe-like camels, deer, mastodons, and many horses. The plains and prairies were well stocked with big game and the forests were thickly populated.

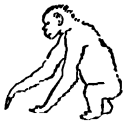
The Pliocene ("more new") covered a period of about ten to twelve

TIMETABLE OF ANIMAL LIFE

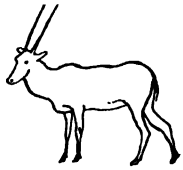
ERA: CENOZOIC (61 MILLION YEARS)

PERIOD: RECENT (50,000 YEARS)

CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Chimpanzee



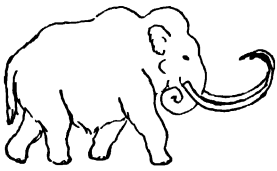
Gemsbok



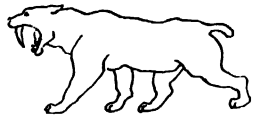
Kangaroo

PERIOD: PLEISTOCENE (1,000,000 YEARS)

CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Mammoth



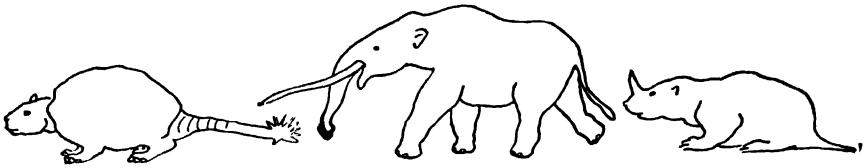
Saber-toothed Tiger



Giant Sloth

PERIOD: PLIOCENE (10,000,000 YEARS)

CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Glyptodon

Pliocene Mastodon

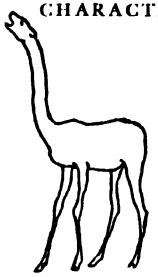
Horned Gopher

NOTE: The animals named and depicted in this chart represent merely a few forms that are characteristic of the various geological periods. It is not to be inferred that they are the only species in existence during a particular time.

TIMETABLE OF ANIMAL LIFE

ERA: CENOZOIC (61 MILLION YEARS)—*continued*

PERIOD: MIOCENE (10,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Giraffe Camel

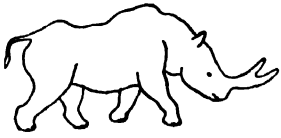


Long-jawed Mastodon

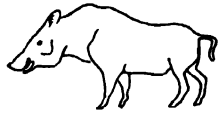


Syndyoceras

PERIOD: OLIGOCENE (10,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Titanothere



Giant Pig



Creodon

PERIOD: EOCENE (20,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Uintatherium



Patriofelis



Four-toed Horse

TIMETABLE OF ANIMAL LIFE

ERA: CENOZOIC (61 MILLION YEARS) — *continued*

PERIOD: PALEOCENE (10,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (MAMMALS)



Phenacodus



Ectoganus



Pantolambda

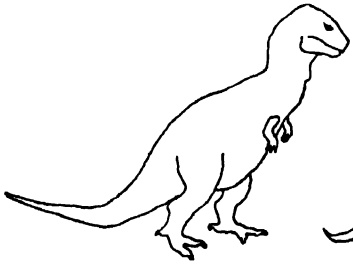
ERA: MESOZOIC (140,000,000 YEARS)

PERIOD: CRETACEOUS (60,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (MAMMALS)

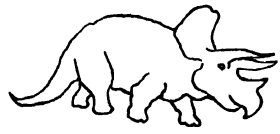


Mesozoic Mammal

PERIOD: CRETACEOUS (60,000,000 YEARS) — *continued*
CHARACTERISTIC ANIMAL LIFE (DINOSAURS)



Tyrannosaurus



Triceratops



Pteranodon

TIMETABLE OF ANIMAL LIFE

ERA: MESOZOIC (140,000,000 YEARS) — *continued*

PERIOD: JURASSIC (35,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (DINOSAURS)



Stegosaurus



Archaeopteryx



Ichthyosaur

PERIOD: TRIASSIC (45,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (DINOSAURS)



Placodus



Nothasaurus



Dicynodon

ERA: PALEOZOIC (340,000,000 YEARS)

PERIOD: PERMIAN (25,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (PRIMITIVE REPTILES)



Pariasaur



Dimetrodon



Varanosaurus

TIMETABLE OF ANIMAL LIFE

ERA: PALEOZOIC (340,000,000 YEARS) — *continued*

PERIOD: PENNSYLVANIAN (20,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (AMPHIBIANS)



Diplovertebron



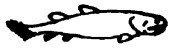
Diplocaulus

PERIOD: MISSISSIPPIAN (30,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (AMPHIBIANS)



Ichthyostege

PERIOD: DEVONIAN (65,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (FISHES)



Lobe-finned Fish



Spine-bearing Shark

PERIOD: SILURIAN (35,000,000 YEARS)
CHARACTERISTIC ANIMAL LIFE (FISHES)



Armored Fish



Jointed-neck Fish

TIMETABLE OF ANIMAL LIFE

ERA: PALEOZOIC (340,000,000 YEARS)—*continued*

PERIOD: ORDOVICIAN (75,000,000 YEARS)

CHARACTERISTIC ANIMAL LIFE (INVERTEBRATES)



Cephalopod



Stalked Crinoid

PERIOD: CAMBRIAN (90,000,000 YEARS)

CHARACTERISTIC ANIMAL LIFE (INVERTEBRATES)



Trilobite



Brachiopod

ERA: PROTEROZOIC — ARCHEOZOIC (1,500,000,000 YEARS)

CHARACTERISTIC ANIMAL LIFE (PRIMITIVE INVERTEBRATES)



Proterozoic Worms (three are shown)

Few fossils have been found that tell us of the earliest stages of life. For long ages, the single-celled animals, or protozoans, were a common form. Untold ages before them life had its beginnings in living molecules, but of these nothing remains.

million years and is noteworthy because animals like those we know today began to appear more and more. There were one-toed horses, rhinoceroses, elephants, lions, saber-toothed tigers, deer, and antelope. The entire world was teeming with game of all kinds.

Dry periods came at the close of this wonderful era. In some places the plains and prairies were drained of moisture by the burning heat; the life-giving rivers and lakes dried up and were not replenished. In certain areas these dry periods increased in severity. The hot winds licked up the moisture on the land and the animals died by the thousands. We find great masses of bones fossilized around what were once dried-up water holes.

FINEST WILDLIFE EVER KNOWN

The Pleistocene ("most new") covered a period of about one million years, which brings us up to the mammals of the present day. They suffered great setbacks when a drastic climatic upheaval brought intense cold. Waters of the oceans were transformed to snow on the polar ice caps, and the great glaciers moved south, destroying almost two-thirds of the wildlife in northern regions. Four times the glaciers covered a good part of the earth.

The Pleistocene, up to the time of the Ice Age, brought the finest wildlife this world has ever known. North America, as well as Asia, teemed with troops of horses, elephants, mastodons, llamas, camels, lions, tigers, yaks, in addition to all the types of animals alive today. The mastodons, woolly mammoths, saber-toothed tigers, giant bison, and many other now extinct species survived the Ice Age, which itself lasted into the Recent period, and were alive on the earth up to fifteen thousand years ago. So far as we know, New World mammoths and ground sloths were contemporaries of the Indians, who came to the Americas perhaps twenty-five thousand years ago.

OF MAMMALS AND CONTINENTS

The shore lines of the large land masses have changed comparatively little during the past sixty million years. During all this time there has been more or less free access between all the continents except Australia. At times, of course, South America was separated from

North America, even as North America is now cut off from Asia, but in the past there were land bridges between them.

It is on the basis of this comparative freedom of access that we explain the fact that many "typical" North American animals—sheep, bison, deer, and bears are some—are actually of Asiatic origin; and others, such as horses and camels, which are found in Asia but were not present in America in recent times, originated in the New World. This also explains why there are almost identical animals like the moose, mountain sheep, bear, and wolf in both North America and Asia. In general, living things have a tendency to spread out over as wide an area as possible, and this has helped keep these large land masses well stocked with game.

However, today each large land mass has its typical animals, no matter where they came from at the start. Africa has the most, for they sought out this warm haven when the Ice Age froze or chilled their former homelands. This continent is outstanding for its large number of antelopes, zebras, big-eared elephants, lions, buffaloes, hippopotamuses, rhinoceroses, gorillas, chimpanzees, and monkeys without grasping tails. Asia, with only a few antelopes and a large number of deer, is noted for its tigers, bears, goats, and ibex, mountain sheep, buffaloes, small-eared elephants, rhinoceroses, wild horses, and camels, as well as gibbons and many kinds of monkeys.

Europe once supported numerous wild oxen, deer, chamois, bison, and wild boars, but most of these have virtually vanished.

North America has its special forms of big game in the musk ox, mountain goat, and pronghorn; but it also is a country of deer, mountain sheep, cougars, and bears (formerly bison, too).

South America has its own particular group of animals that includes the llamas, peccaries, tapirs, anteaters, sloths, armadillos, opossums, jaguars, capybaras, and a specialized group of monkeys, those with grasping tails.

The Australian region's outstanding animals are the marsupials—kangaroos, wallabies, koalas, and opossums—as well as the egg-layers, the platypuses and echidnas. New Zealand does not have a single native land mammal and never had any except two kinds of bats. All others found there today came in rather late or were imported.

Madagascar features a large variety of lemurs and a distinctly different group of insect-eating animals.

The seals are more or less concentrated about the polar regions,

the sea lions and fur seals are found mostly in the Pacific Ocean and the southern seas; the sea cows are now restricted to the coastal waters of the warm seas. We find whales and porpoises on all seas, but they are most abundant in temperate and colder waters.

This, so to speak, is the mammal map of the world. It is a map that has not changed much during the brief span of time in which man has achieved dominion over other living things. In earlier ages it changed greatly. That the process of alteration has not been completed we may rest assured, as coastlines sink and mountains rise, and the climate gradually changes. Mother Earth never ceases in her activity, and what new wonders she may bring forth in the long tomorrow no mere member of one of her newer species can say.

BOOK II: Birds of the World

DEAN AMADON

E. THOMAS GILLIARD

The Birds—Winged Wonders of the World

How do we recognize a bird? The most obvious answer is: by its feathers.

All birds, and only birds, have feathers; but not all birds can fly! The flightless birds are few in number, and their feathers have undergone certain changes. Thus the feathers of penguins are hard and small. The feathers of the cassowary of New Guinea have become almost like the tines of a pitchfork. But the vast majority of the 8,600-odd species of birds have typical feathers.

The most striking feature of birds is their wings, which correspond to our arms, or to the forelegs of a mammal or reptile. In a few birds the wings have become much reduced in size. But even the flightless ostrich uses its wings to steer itself as it dashes at phenomenally high speed across the African plains.

The normal body temperature of a bird may be as high as 104° Fahrenheit. Birds lead intensely active lives and in some ways are the most highly evolved of living creatures. To be sure they do not have the mental capacities of the higher apes, much less of man himself. Yet ravens and parrots do as well on "intelligence tests" devised by animal psychologists as do horses or cats.

HOW BIRDS STARTED—MILLIONS OF YEARS AGO

Scientists know from their study of fossils that birds evolved from reptiles. The same is true, of course, of mammals; but these two warm-blooded groups—the pinnacle of the tree of life—arose from different groups of reptiles and hence are not so closely related as their common origin might suggest. Birds have remained more like reptiles than have mammals. All birds lay eggs, whereas only two or three primitive mammals lay eggs. (The best known of these is the duck-

billed platypus of Australia.) The famous biologist Thomas Huxley called birds "glorified reptiles."

It was in Bavaria that paleontologists—scientists who study the fossil life of past geological eras—discovered the "missing link" between reptiles and birds. They found the traces of this creature in fossil beds laid down in the Jurassic period, about 125 million years ago. Since it is the oldest of fossil birds, they named it *Archaeopteryx*—"ancient winged-one."

Archaeopteryx had feathers and could fly. If not for the clear imprint of its feathers in the rock, the scientists could not have recognized *Archaeopteryx* as a bird, for it had numerous teeth, wing-claws and a reptile-like skull. (The absence of teeth in present-day birds is proverbial: "As scarce as hens' teeth.") The well-developed claws on its wings helped *Archaeopteryx* to make its way through the lush tropical vegetation of that ancient time. Another interesting feature of *Archaeopteryx* was its long lizard-like tail, containing some twenty vertebrae, each with a pair of large tail feathers.

This "ancient winged-one" lived in the "age of reptiles"—a time when not only birds, but also mammals, were first appearing on the scene to challenge the supremacy of the gigantic but slow-witted dinosaurs and their lesser cousins. In the Cretaceous period which followed, the dinosaurs reached their greatest size; but at the close of that period they, and many other groups of reptiles, disappeared completely, and were replaced by birds and mammals.

The birds of this Cretaceous period had the tail bones fused into a short mass, as do living birds of our time—but they still had true teeth, like their ancestors. Among the remarkable birds of the period was *Hesperornis* ("western bird"), highly specialized for swimming and diving.

This creature received its name from the fact that it was discovered in Kansas in the 1870's by an expedition headed by Professor Othniel Marsh of Yale, who is said to have employed Buffalo Bill as his guide. From early boyhood, Marsh had been interested in fossils, and when he was left one hundred thousand dollars by a wealthy uncle, he was able to indulge to the fullest his passion for fossil-hunting.

Ninety million years ago, the period when *Hesperornis* flourished, Kansas was an inland sea, a suitable habitat for this flightless bird, with its swimming and diving adaptation. The fossil was about five

feet long and had ninety-four teeth; but it had already lost many of the reptilian features found in the more ancient *Archaeopteryx*.

The Cretaceous was followed by the Tertiary period, which began some seventy million years ago and is still going on. This has been, and is, the age of mammals, birds, and insects. Unfortunately our knowledge of the development of bird forms is by no means so full as in the case of the mammals. Fossils of mammals are comparatively plentiful, whereas birds, in view of their flying powers and their light, hollow bone structure, are rare in fossil deposits.

We do know, however, that by the beginning of the Tertiary period, or shortly thereafter, birds no longer retained their teeth, and many types not much different from our present birds inhabited the earth.

FEATHERS AND FLIGHT

Some lizards have scales with elaborate frills, and it was probably from such scales that the feathers of birds were derived. The first use of feathers was to insulate the body against extreme cold or heat. This helped make possible the change from a cold-blooded, sluggish reptile to a warm-blooded, animated bird. But feathers also proved useful in gliding and later in flying, and their structure gradually became modified for this purpose. This was especially true of the wing quills, which are essential for flight.

Feathers are amazingly light and strong. Thousands of microscopic hooklets hold together the filaments of each feather. If the hooklets get pulled apart, the bird preens the feathers with its bill, deftly relinking the countless barbs and barbules and thus restoring airtightness and smoothness to the feather vane (the flat extended part of the feather).

As the bird preens its feathers it also rubs oil over them to make them smooth and waterproof. This oil is secreted by glands at the base of its tail. In birds that are no longer able to fly, the feathers usually become soft and downy and serve only to keep the body warm. The ostrich is a case in point.

Every part of a bird's body is adapted for flight. The body cavity and the longer bones contain air sacs, which are connected with the lungs. These air sacs help make the body buoyant and increase the supply of air to the lungs. The breast muscles—the muscles used for

flying—make up a large part of a bird's body, even in such a poor flying bird as the domestic chicken or turkey. A bird's breastbone has a large projection, like the keel of a boat, to which the flight muscles are firmly attached.

The feathers of a bird's wing overlap in such a way that there are no holes or gaps for the air to slip through when the wings are brought down. On the up-beat, the air slips between the feathers. Thus the bird is propelled upward and forward by powerful strokes of its wings. When the feathers become worn, they fall out ("molt"), and new ones grow in.

Large birds are able to sail and soar for long distances without flapping their wings. This they do by utilizing their momentum to lose altitude slowly. But when there are favorable rising currents of warm air they can soar for hours, almost without effort.

Birds generally give the impression of flying faster than they actually do. Small sparrows and other small birds usually fly no faster than fifteen to twenty-five miles an hour. Ducks are capable of up to sixty miles an hour, and certain falcons and swifts go still faster. When diving after their prey, eagles attain velocities of perhaps as much as 125 miles an hour, and the sound of air rushing through their pinions can be heard for a considerable distance.

SIGHT, HEARING, AND SENSE OF SMELL IN BIRDS

Birds have very keen vision. A flycatcher, for example, can discern an insect some distance away and seize it in the air. In most birds the eyes are placed at the sides of the head; they must peer at an object with one eye. Owls, however, have the eyes in the front of the face and they are able to focus both eyes upon an object as we do. Owls and other night birds have very large eyes to aid them to see in twilight or moonlight. While they do not like bright sunlight, it is not true that they are unable to see by day.

Although owls can see fairly well at night, their marvelous sense of hearing is a valuable aid in catching their prey. Owls placed in a totally dark room, where they cannot see anything, are able to catch mice by hearing them scamper about on the floor. Birds of the day also have good hearing, but they use it chiefly to aid them in escaping from enemies. The hearing of birds does not seem to be affected by

the fact that the ear openings are usually rather small and hidden by the feathers of the head.

Birds have a very poorly developed sense of smell, and many birds seem to lack it altogether. There is good evidence, however, that the curious kiwi of Australia can smell earthworms and other food it likes to eat. There has long been debate as to whether vultures are attracted to carrion by its odor.

THE AMAZING MIGRATIONS OF BIRDS

Some birds, such as the snowy owl, migrate only when their normal food supply fails. Ducks may remain in the north until they are actually forced to move south by the freezing of lakes and rivers. In the case of song sparrows, the females and young birds migrate; but many of the old males, perhaps because they are hardier or have a stronger attachment to home, remain in the north. These partial migrations help us to understand how the long and mysterious migrations of other species developed.

We can here mention only a few of these remarkable longer migrations. The bobolink nests in the fields of the United States, but it winters on the pampas of the Argentine. The bristle-thighed curlew nests in Alaska and then flies two thousand miles or more across the Pacific to spend the winter in Hawaii and other islands of the South Seas. The cuckoos of England migrate south to Africa in midsummer, leaving their young to follow them, under the sure promptings of instinct, some weeks later. The Arctic tern nests as far north as the Arctic Circle and sometimes journeys to the Antarctic seas to spend the winter—a round trip of twenty-two thousand miles.

It is obvious that on these long trips endurance is at least as important as speed. Ducks, geese and plover average a rate of about forty-five miles an hour; the speed will be affected favorably or unfavorably by wind conditions.

Sometimes swift, catastrophic weather changes may inflict a fearful toll on migrating flocks. A sudden shift to wintry weather in autumn or spring has been known to kill as many as three-quarters of a million birds in a small area. One weather change that had a comparatively happy sequel occurred during the fall of 1931, when large numbers of migrating swallows and martins perished in Europe. The

bird-watchers of Vienna managed to rescue ninety thousand of the unfortunate birds and, after nursing them back to health, sent them on to Venice by plane. There they were freed to continue southward.

How do birds find their way on these long migrations? Despite much study, and experiments with banded birds, we still do not have the full answer to this question. There is no doubt about the phenomenal ability of birds to return to their homes; but do they accomplish this by means of memory, vision, and exploratory flights —or by some as yet unknown "sense of direction"? We do not know.

Many young birds migrate without guidance from older birds who have made the journey before. We must suppose that they inherit an instinct to fly in a given direction. There are a number of natural events, such as the seasonal change in the position of the sun, that might serve as the basis for an instinct to fly in a particular direction. Some scientists have suggested that birds can guide themselves by sensing the north-south magnetic field that surrounds the earth. Most evidence indicates, however, that birds are not influenced by magnetic waves.

Recently it has been shown that some birds can orient themselves in a given direction so long as the sun is visible, and regardless of the time of day. The position of the sun changes constantly throughout the day, and we are forced to conclude that such birds possess some way of telling time; that is to say, they allow for the changes in the position of the sun.

COLOR FOR DISPLAY—AND CONCEALMENT

The feathers of birds are endlessly varied in color and design. Many of the most brilliant and glittering colors are produced not by pigments, but by the microscopic structure of the feather, which reflects certain colors and not others. Bright blue feathers, for example, when ground to powder, lose their blue color. No blue pigment is present, and once the structure of the feather is destroyed, the color vanishes.

Some birds are streaked and mottled with brown, matching perfectly the fields or forest floor on which they live. Other species are clad in brilliant ornamental plumes suitable for courtship displays. Often these colorful feathers are replaced by less flamboyant ones when the mating season is over.

In the case of other birds, such as the pheasant, the cocks have

brilliant colors while the hens are camouflaged. The hen is safer as she broods on her eggs or cares for the chicks. The cock pheasant may fall victim to a fox or other enemy because of his bright colors; but, since the species is polygamous it is not essential that there be as many males as females. Brilliantly colored birds often live in a tropical forest where they are more or less concealed by the somber shadows except when they seek, for a few moments, some more exposed position in which to perform their courtship displays and dances.

Displaying their plumage is not the only way male birds attract their mates. Song has the double function of attracting a mate and of threatening other male birds. Each male will set up a little territory in which he sings and in which he and his mate remain and nest. Among some birds both male and female build the nest and care for the eggs and young. In the case of others, such as the grouse, the cock bird takes no interest in his mate once the eggs are laid.

By marking individual birds with bands we have learned that birds, as a rule, form no strong attachment for their mates. Wrens may raise three broods in a summer, changing mates between each brood. On the other hand, hawks and eagles use the same nest year after year, and often the same pair remains mated. However, the attachment may be to the nest site rather than to the mate; if one of a pair returns from the south before the other, it may get a new mate before the return of its partner of the previous year. Geese, doves, and a few other birds do become attached to their mate, and if one of a pair is lost, the other may refuse for some time to accept another mate.

WHAT DO BIRDS EAT?

Birds lead so active a life that they need to eat a great deal. The diet varies with the type of bird. Chickens scratch in loose earth with their strong feet and pick up insects and seeds they uncover. Ducks use their flat bills to sift through silt and muck in search of clams or the seeds of water plants. Hawks and owls catch mice in their sturdy curved claws or talons and then use their hooked beaks to dismember their prey. Herons wade slowly along the border of some shallow pond, and spear frogs and fish with a lightning-like stroke of their pointed bills. Swallows fly tirelessly through the air, catching small insects in their broad short bills. Loons, propelled by their strong webbed feet,

dive far below the surface of the water in pursuit of fish. Woodpeckers tunnel in dead trees in search of wood-boring grubs and ants. Parrots and grosbeaks crush hard fruits and seeds with their powerful beaks to get the kernel. Vultures soar high in the blue, their keen eyes scanning the ground for any bit of refuse or offal. These are a few of the techniques that birds have for getting their food.

As we have seen, birds have a high body temperature and they use up a great deal of energy in flying and other activities. Consequently they need a lot of food, and they must digest it rapidly. One part of a bird's stomach, called the "gizzard," has thick, muscular walls and a strong, rough-surfaced lining. It is here that the bird's food is broken up and crushed before it passes on to the intestines. The gizzard usually contains grit and gravel, swallowed by the bird, which aid in grinding up hard foods like grain. Many birds have an expanded area in the gullet, known as the "crop." Here they can retain food until there is room for it in the gizzard.

HOW LONG DO BIRDS LIVE?

Small birds have many enemies—foxes, cats, weasels, and even other birds, such as hawks and owls. Disease sometimes kills them in large numbers, as do storms, particularly during migration. Small wonder, then, that the banding records prove that the average life of most birds is short, often no more than a year or two. Occasionally small wild birds live to be five or six years old; pet canaries may live twice that long. There is much evidence that wild songbirds do not enjoy the idyllic existence portrayed by the poets.

Large birds live much longer than small ones. A great horned owl lived for sixty-eight years in the London Zoo. It is doubtful whether any bird survives that long in the wild, but eagles, geese, and many others probably live for fifteen or twenty years or even longer.

BIRDS AND MAN

Man has been responsible for the disappearance of many birds, not so much through outright extermination as by the gradual encroachment of housing and industry on the countryside. As for the birds, they have conferred many benefits on man. We all know of the immense value of domestic turkeys, pigeons, ducks, geese, and above all,

chickens, to man. Wild birds are also of great economic importance. Vast numbers of waterfowl, pheasants, grouse, pigeons, and other species are shot or netted for food in all parts of the world.

Aside from the economic motive, many people enjoy hunting as a form of sport and recreation. The eggs of wild birds are often gathered for food; in Norway the down which eider ducks use to line their nests, makes excellent pillows and blankets.

Birds are of value to man in still other ways—some of them bordering on the fantastic, as the use by the Chinese of the hardened saliva in swifts' nests to make soup. The feathers of birds are used in millinery and in tying trout flies; indeed, certain species were hunted so relentlessly for their plumage that laws had to be passed to prevent their extermination. (Similar legislation and the creation of bird sanctuaries have given a new lease on life to many species that were menaced with extinction because of indiscriminate hunting.)

The world's most commercially valuable wild bird is the Peruvian cormorant, the source of a fertilizer thirty times more effective than ordinary farmyard fertilizer. The exportation of guano yields millions of dollars of revenue every year, but its useful properties were known and appreciated at least as far back as the days of the Incas.

Birds aid man the world over by devouring vast numbers of harmful insects and weed seeds. To be sure, some birds occasionally reverse this procedure and consume fruit or grain that man has planted for his own needs. On balance, though, the birds do infinitely more good than harm.

More difficult to assess in concrete terms, but no less real, is the deep and abiding pleasure we receive from the bright hues, sprightly behavior, and melodious songs of birds. Such benefits are enjoyed just as much by the housewife with a pet canary as by the naturalist who has seen his first wild bird of paradise. It was such qualities that led the late Frank M. Chapman to call birds "the most eloquent expression of Nature's beauty, joy and freedom."

Ratites—Giant Birds That Cannot Fly

WHEN WE THINK of birds, we think of their glorious ability to soar up into the blue. The flight of birds is our favorite symbol for freedom, for adventure into the unknown, for joyous release from dull earthbound care.

It therefore comes as something of a shock to us when we learn that some birds cannot fly. Scientists call these birds "ratites" (from the Latin word for "raft"), because the flightless birds have flat breastbones. Flying birds have a keel on the breastbone to support their flying muscles.

The flightless birds—most of them very large—include the ostriches, emus, cassowaries, moas, rheas, and kiwis. The naturalists place them in a special group called "Ratitae." Although all these birds have small weak wings, they are descended from flying birds. Some other birds have lost the ability to fly; but in these latter the keel, though sometimes reduced, is still present.

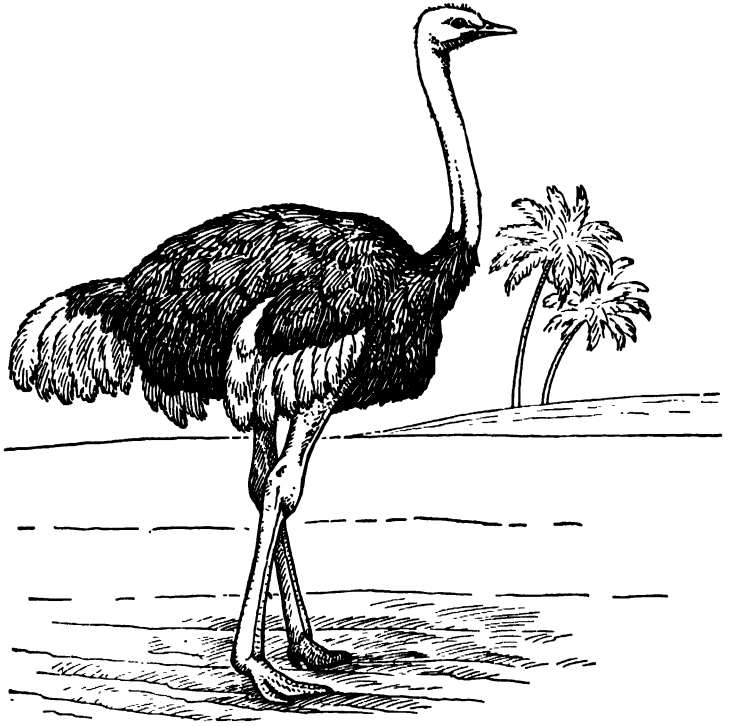
A good many of the giant ratites live on islands, where they have few enemies, or none at all. Under such conditions there is little need for flight; body size, therefore, is apt to increase well beyond the thirty-pound maximum of flying birds. Thus the birds evolved into their present form.

OSTRICHES—FLIGHTLESS AND FLEET-FOOTED

The African Ostrich, *Struthio camelus,* is the largest of living birds and the best known of the ratites. The ostrich is the only sizable flightless bird that lives in a country beset with large preying mammals such as lions and cheetahs. Standing seven or eight feet tall and blessed with keen vision, the ostrich is usually able to elude its enemies. When it is running at full speed the ostrich has a stride of about

twelve to fifteen feet, and it can outrace most of its enemies on the African plains. Forty miles per hour is a fair estimate of its speed.

Most of us have heard at one time or another that the ostrich hides its head in the sand when confronted by danger. This is quite untrue. Contrary to common belief, the ostrich kicks viciously when cornered or wounded. Ostriches differ from all other birds, by the way, in having only two toes on each foot.



THE OSTRICH—FLIGHTLESS, BUT A FAST RUNNER

Though unable to fly, the ostrich is by no means helpless against its enemies. Its twelve-foot stride carries it along at a good forty miles an hour. This giant bird can sense danger from afar, as it is over seven feet tall and has keen vision.

A curious feature of ostrich life on the African plains is that zebras and gnus often accompany these great birds. The explanation seems to be that the ostrich, by reason of its height and vision, is particularly sensitive to distant threats of danger; the zebras and gnus are thus able to achieve safety to a degree impossible by their own efforts. If the ostrich moves off warily, its "associates" follow its example.

The ostrich is at home in all the drier or more sandy parts of Africa. Once it lived in Syria and Arabia. Scientists have found fossil ostriches and their eggs in Mongolia and China—but these became extinct before the dawn of civilization, about 5,000 B.C. There is no reason to believe that they ever reached America by way of the land connection that is known to have joined Siberia and Alaska during some of the past geological ages. The South American "ostrich" or rhea is not closely related to the African ostrich, which the naturalists have assigned to the family Struthionidae.

Large ostriches weigh about three hundred pounds. They are handsomely adorned with fluffy black and white plumes once highly prized in the millinery trade. The female has a duller brownish coloration than her mate, and she is somewhat smaller. The male ostrich produces a booming note that has been likened to the muffled roar of a lion. During this performance the loose skin of the neck expands under pressure of air.

The food of the ostrich includes most anything fit to eat—vegetable matter for the most part. In fact, it will swallow bits of broken rock, which have a genuine grinding value in the functioning of its large gizzard. (This is the bird's second stomach where its food is ground up by the action of the muscular walls.)

THE BREEDING HABITS OF OSTRICHES

Ostriches pair at the beginning of the nesting season and the male scrapes a shallow nest-depression in the ground with his claws. There are times, generally in captivity, when several hen ostriches mate with one cock and lay their eggs in a single nest. But polygamy is usually unsuccessful, perhaps because of conflict between the hens—they all wish to incubate the eggs.

The hen lays some fifteen buffy-white eggs weighing about three pounds apiece. With the hen incubating by day and the cock by night, it takes six weeks or so for the chicks to hatch. The agile, precocious chicks are covered with prickly, stiff-pointed down and look like small porcupines!

OSTRICH FEATHERS—GLAMOROUS AND PROFITABLE

Ostrich plumes have been esteemed as ornaments for thousands of years. Interestingly enough, it was only in quite recent times that

women, rather than men, began to adorn themselves with ostrich feathers. The demand grew so sharply in the nineteenth century that the ostrich was soon in danger of being exterminated. We have a record of a shipment of twenty tons of ostrich plumes in 1909, valued at half a million dollars!

Luckily the senseless policy of butchery gave way to domestication when the British in Africa discovered, about a hundred years ago, that ostriches are quite docile and prolific in captivity. The plumes can be plucked without harming the giant bird, which proceeds to grow replacements. After a while, the changing styles in women's headgear left ostrich ranchers "out on a limb."

By way of fantastic footnote, it is interesting to observe that ostrich plumes have not been the only reason for massacre. One of the Roman emperors had the weird idea of serving up the brains of six hundred ostriches as a delicacy at a banquet!

Under normally safe conditions of captivity, ostriches are fairly long lived. While we do not have completely reliable figures, some authorities claim that ostriches have lived to the age of seventy.

MOAS—EXTINCT BIRDS THAT WEIGHED FIVE HUNDRED POUNDS

These giant flightless birds are no longer in existence. They lived in New Zealand until the Maoris, its present Polynesian inhabitants, arrived about one thousand years ago. The Maoris exterminated the two or three remaining species of moas before the coming of the first Europeans. Thus the family Dinornithidae became extinct.

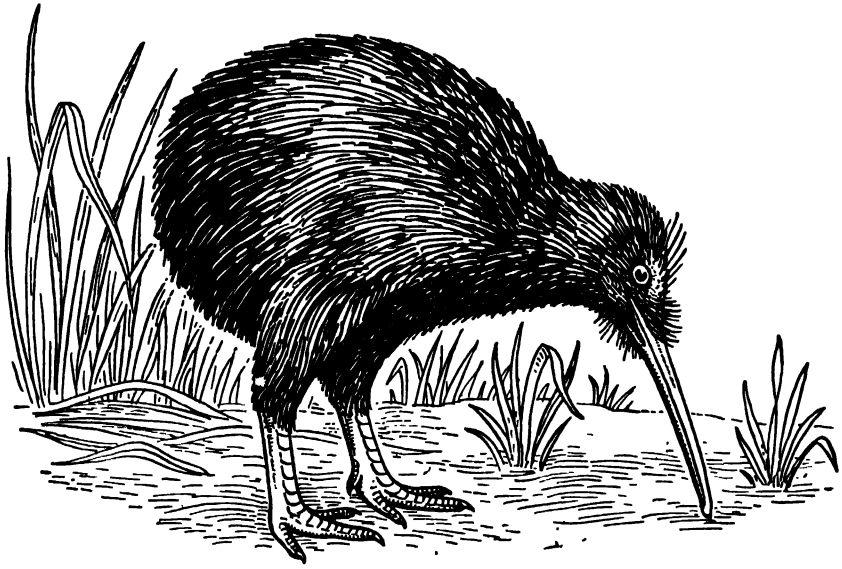
The largest moas were ostrich-like in appearance, stood about nine feet tall, and weighed approximately five hundred pounds. There were no native mammals in New Zealand aside from bats. Thus the moas had few or no enemies until man arrived. In these peaceful surroundings the moas became larger and more sluggish—hence more helpless—as time went on. Their relatives, the kiwis, survive in New Zealand.

KIWIS AND THEIR ODD WAYS

The three species of New Zealand kiwis are the smallest of the ratites. In many ways they are the oddest birds in the world. These exceptionally shy birds—they make up the family Apterygidae—are prob-

ably specialized moas that escaped the grim fate of their larger cousins because of their superior ability to hide in the dense New Zealand "bush." The introduction of dogs and swine into the New Zealand forests played havoc with the kiwis, and some of the species are threatened with extinction.

About the size of a large domestic fowl, the kiwi is covered with long, straggly, hairlike brown or gray feathers. This simple or degenerate type of feather structure occurs in many of the ratites and is undoubtedly related to the loss of flight.



A BIRD THAT CANNOT FLY

The flightless kiwi of New Zealand lays an egg that is one-fourth its own weight! It is by far the largest bird egg in proportion to the size of the adult. The egg takes a good eleven weeks to hatch, and in turn the chick needs three years—sometimes more—to grow into an adult. This primitive bird has one important asset—unlike most other birds, it has a good sense of smell which helps it to find food.

The kiwi has a long, curved bill, with sensitive nostrils opening at the tip. With this bill the bird probes for earthworms, doing most of its feeding at night. It is one of the few birds that have the sense of smell well enough developed to be of use in finding food.

The egg of the kiwi is larger in proportion to body size than that of any other vertebrate animal in the world. The egg weighs one pound, the bird four pounds! The incubation period lasts about seventy-five

or eighty days—almost a record for birds. The male does all the incubating. Though fully feathered at hatching time, the chick takes three or four years to mature.

The kiwi gets its name, given it by the Maoris, from its characteristic courting cry—a shrill whistle sounding like "k-wee." The kiwi's flightless character has some amusing slang uses, particularly among the British: a nonflying air-force man, a student pilot, or a poor flier is called a "kiwi."

EMUS–RIVALS OF THE KANGAROO

The Emu, *Dromaeus novaehollandiae*, the national bird of Australia, is the second largest of living birds. Adults average five feet in height but appear much smaller than the ostrich because of their stooped posture. They favor plains and open forests and are swift runners.

The only surviving emu, the last of the family Dromaeidae, is confined to the wilder plains of Australia, but formerly emus were very abundant in most of Australia, on islands in Bass Strait, on Tasmania, and on Kangaroo Island, in the seas south of Australia. Extinction has overtaken the island populations so rapidly that only a single specimen exists of the dwarf Kangaroo Island emu. Of the other island species, now vanished, we know practically nothing.

Emus differ from their near-relatives the cassowaries by being dull-colored, having the head feathered (not covered with a bony helmet), and by living in grasslands (not in deep forest). They are like the cassowaries in being monogamous and, in this respect, differ from the rheas, which are polygamous.

Again like the cassowary, the emu is a powerful swimmer. In the nonbreeding season emus move about in small flocks, but when nesting time arrives, the adults pair off. The female lays seven to twelve or more rough-surfaced, greenish-black eggs in a depression in the earth. The male takes care of the brooding (eight weeks) and attends to the needs of the young. They emerge covered with grayish down, camouflaged with greenish stripes. Strangely enough, while the female emu may incubate for a short period after she lays the eggs, she is always chased away by her mate, who thereupon takes charge. The female, incidentally, is larger than the male.

Although they are reputed to have a gamy, rather unpalatable flavor, emus are hunted extensively, often with dogs. There are reports

that they do much damage to wire fencing by crashing into it. Feeding exclusively on vegetable matter, they compete to some extent with grazing livestock.

The emu's call, remarkably loud and booming, is probably amplified in a curious pouch which, in both sexes, is connected with the windpipe.

CASSOWARIES—DANGEROUS BIRDS

Cassowaries are probably the most dangerous birds in the world. When cornered or wounded, they kick forward or sideward with lightning speed. They have an immense stiletto-like claw on the innermost of the three toes. The long neck and bill are also potent weapons.

These large flightless birds live in New Guinea, a few surrounding islands, and the northern tip of Australia. There are three known species, making up the family Casuariidae. They differ from all other ratites by having a large bony casque or helmet on the top of the head, and a neck that is naked, wattled, and brilliantly tinted with blue, red, purple, and yellow. Their wing quills, which are black, remind us of the tines of a pitchfork.

A typical cassowary, such as the Two-wattled Cassowary, *Casuarius casuarius,* is about five feet tall, very heavy bodied, and stoop shouldered. The short, brightly colored wattles hang from its naked lower neck. Its head is helmeted with a high bladelike casque; its bill is narrow, with large nostrils opening near the tip; and its body plumage is coarse and glossy black.

Aside from the head and neck differences, cassowaries are unlike most other ratites, too, in favoring deep forests rather than open grasslands. On a field trip in New Guinea we found cassowaries numerous in the deepest parts of original valley forest and saw their strange three-pronged tracks along the banks of many forest streams. Often, in the woodlands, we heard their call—a deep resonant croak.

A typical young bird we saw stood some one and one-half feet tall; its feathers were brown, striped vividly with buff. This bird was as tame as any barnyard fowl. Yet, near Port Moresby, we were appalled to see a young man whose abdomen had been horribly torn and disfigured by the vicious kick of a "tame" cassowary.

It is curious that the cassowary can swim flooded rivers with ease, and even bathes in the open ocean. It can sprint at speeds of nearly

forty miles per hour and leap six or more feet in the air with ease. Being quite shy, it goes abroad in the early morning or late evening to feed on fruit, insects, and vegetable matter.

Cassowaries nest on the ground in the deep forest, where, in a little cavity lined with leaves and grass, the female lays from three to six pear-green eggs. The male incubates the eggs for some seven weeks, and cares for the young. In the nonbreeding season, cassowaries often gather in loose bands of from six to fifteen.

To the natives of Papua cassowary meat is a great delicacy, and when a kill is made the huge carcass is immediately skinned and dismembered for cooking and smoking. No part is wasted, and the liver, which is indeed delicious and tender, is most prized.

ELEPHANT BIRDS—THE HUGEST BIRDS KNOWN

We know the gigantic Elephant Bird, *Aepyornis maximus* ("giant bird"), of Madagascar, only from fossil remains and eggs; but it is worth mentioning because it was larger than any other known bird, living or fossil. It became extinct not very long before the dawn of civilization, about 5,000 B.C. Some experts believe that Marco Polo's account of the legendary Roc may have been based on the elephant bird. The roc, according to ancient tales, was a bird of Arabia so huge that it was able to carry off elephants in its claws to feed its young!

The elephant bird, which made up the family Aepyornithidae, was no taller than the biggest moa (about nine feet). But the bones of the elephant bird were more massive and it weighed about a thousand pounds. Its eggs have been found in surprising numbers in swamp muck. They are much larger than those of the moa, measuring some twelve or thirteen inches long. They probably weighed about eighteen pounds when fresh.

We can best explain the existence of such flightless heavyweights as the moas and elephant birds by assuming that they evolved independently from flying ancestors. As we have seen in the case of the moas, the "easy life" found on remote islands favors gigantism in birds. This is true of other animals such as the colossal turtles of the Galápagos Islands.

RHEAS–SOUTH AMERICAN COUSINS OF THE OSTRICH

The largest New World birds are the rheas or American ostriches, of which there are two species (family Rheidae), both native to southern South America. Several feet shorter than the African ostrich, and with three toes instead of two, the rhea is flightless.

The rhea is polygamous. During courtship the males emit deep booming notes and fence with one another, using their bills and long necks as weapons. Like the male emu and cassowary, the male rhea carries out all duties connected with incubation—a task which involves warming two to five dozen large eggs for some six weeks, after they have been deposited in a single shallow earthen depression by his harem. The eggs are golden yellow to rich green, depending on the species.

Young rheas are feathered to the toes. They make attractive, trusting pets, but their habit of gobbling down anything they can get into their mouths makes them rather a liability around the house. The rhea eats vegetable matter such as seeds, grass, and tender roots, in addition to mollusks, lizards, and worms.

Rheas live on remote pampas (the great South American plains) and highland savannas containing occasional bushes and trees. They usually move about in parties of from two to thirty. The members of such a group are keen of sight, very fleet of foot, and they run with wings open and neck extended. They often hide by lying flat on the ground.

The American Rhea, *Rhea americana,* is a dark gray ostrich-like bird about four feet tall. It has long, heavy, naked legs. The three toes have short blunt nails. The rhea's neck is long and slender, with blackish feathers near the shoulders, and grayish plumage about the head. The under parts are dull grayish white; the bill is large and flat. The lores (space between eyes and bill) are naked and black, but otherwise the head is thickly adorned with hairlike feathers. Although they lack the beautiful plumes of the cock ostrich, rheas are slaughtered for their feathers, being captured in large numbers by the use of the *bola* (the South American lasso). Ironically enough, the sinews of the rhea's legs are favored material for making the *bola.*

Tinamous—South American Game Birds

TINAMOUS resemble quail and, like them, are gifted with an amazingly rapid, almost rocket-like flight which does not last very long. They rarely fly more than a hundred yards. If forced to make several takeoffs in succession, they soon become utterly exhausted. Sometimes their furious starts are so rapid that the birds dash themselves to death against tree trunks or other obstructions.

One of the most startling experiences that can befall you in a tropical jungle is to have a large tinamou make its "jet-propelled" takeoff at your very feet. Yet this experience is not uncommon, for tinamous are fond of squatting on jungle trails, where they blend perfectly with fallen leaves. They seem never to take flight until the last possible moment. These characteristics have led many sportsmen to class the tinamou as one of the finest of game birds. In past years frozen tinamou from the Argentine appeared on the menu of our larger hotels under the name of "South American quail."

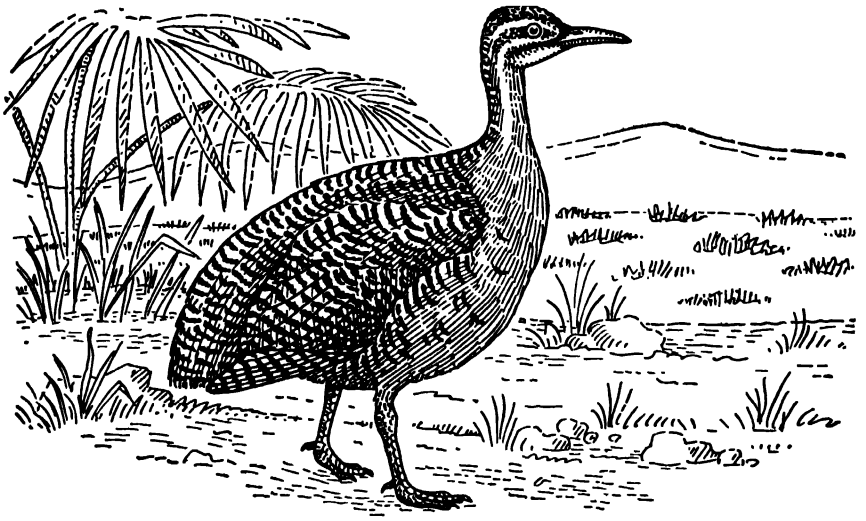
The thirty-two species of tinamous are native to South and Central America. However, a few dwell as far north as Mexico. All are primitive three-toed ground birds, placed in the order Tinamiformes. Their nearest relatives are perhaps the much larger rheas.

There are two main types of tinamous—those of the grasslands and those of the deep forest. Both have similar habits. They live almost entirely on the ground and fly only when forced to. They never perch in trees. Usually they live a solitary life, except during the breeding season, when they pair.

The tinamou usually places its nest under vegetation at the foot of a large tree. Tinamou eggs vary from lavender to rose, depending on the species. They have a unique burnished texture. The male does the incubating—a matter of three weeks—and he cares for the young. He will even feign injury in order to lure preying animals away

from the nesting grounds. The marauder chases the parent bird and is thus led away from the nest or young.

The young are thickly covered with rich brown and buff down, and vividly blotched with black. They are able to run as soon as they emerge from the shell. Chicks we observed on the floor of deep forest in southeastern Colombia blended perfectly with fallen leaves.



IT FLIES LIKE A ROCKET

A bird of South America, the tinamou is noted for its short, headlong flight. Just as startling is the tinamou's takeoff, which is so abrupt that the bird sometimes crashes against a nearby obstruction. As a rule the tinamou stays on the jungle floor, where its coloring blends admirably with the foliage. Some tinamous, however, such as the rufous tinamou, shown above, live in open country.

The tinamou has a clear, melodious voice—usually an oft repeated whistle that filters softly through the forest both morning and evening throughout the year. The bird feeds on fallen berries, seeds, tender roots, and insects.

The Chestnut-headed Tinamou, *Tinamus major,* ranges from southern Mexico to Brazil in the deep tropical forest. Fowl-sized, this tinamou has long bare legs, each ending in three strong but short-nailed toes and a short hind claw. Above, its body is deep reddish with incomplete black bars; the under parts are brownish gray with irregular wavy impressed black lines. Its neck is relatively long and slender; its head is small, with a short, slightly curved bill.

Penguins—They Flourish in Bleak Wastelands

ONE OF NATURE'S most dramatic contrasts is that between the jolly, whimsical penguin and the dreary wastes where this strange flightless bird lives.

The stout-bodied penguin is one of the best known and most loved of birds despite the fact that few people ever see the wide, wobbly-legged, short-necked creature on its home grounds. The penguin is both the most "human" and the most "comical" of birds. Its upright stance, flat feet, short stump of a tail and gawking stare are boons to the artist and the caricaturist.

The penguin's shape and posture are so distinctive that we cannot mistake it for any other bird. Long ago, however, it used to be confused with the great auk, which is now extinct. The resemblance was a pitfall of long standing—indeed, the very name "penguin" was originally applied to the great auk of the North Atlantic. This auk belonged to a very different family, yet it closely resembled flightless sea birds observed in the Southern Hemisphere by early seafarers. Today, with the disappearance of the great auk, the Southern Hemisphere birds have inherited the name.

Some seventeen species of penguins are known, and naturalists group them in the order Sphenisciformes ("short-winged birds"). They range in size from the Little Blue Penguin of Australian and New Zealand waters, which is about twelve inches tall, to the Emperor Penguin of the Antarctic continent, which is more than three feet tall. They vary in weight from four to ninety pounds.

Although we are apt to think of the penguin as a bird of the South Polar regions, only two species, the emperor and the Adélie penguins, live on the Antarctic continent. The rest live in southern seas,

occupying islands and barren coasts in the sub-Antarctic or Temperate Zones as far north as Australia, New Zealand, South Africa, and South America. In western South America, which is washed by the cool waters of the Humboldt Current, penguins reach Peru and the Galápagos Islands.

A CLOSE-UP VIEW OF THE PENGUINS

Some kinds of penguins have ornamental tufts of feathers on the head; these are often yellow in color. Indeed, the differences in color among the species of penguins are largely restricted to the head. In the evolutionary scheme of things, penguins probably developed this peculiarity because the head is the only part visible to the birds as they seek to recognize one another in the water.

Penguins have the bill plated like that of the albatross, to which they are perhaps distantly related. The quill-less wing is modified to such an extent that it resembles a flipper. (This accounts for the first part of the bird's scientific name, the Greek word *sphen* meaning "wedge-shaped"—an allusion to the shrunken wing.) Penguins literally fly under the surface of the water with the aid of these flippers, but they can no longer lift their heavy bodies into the air. They swim with a powerful overhand stroke and have amazing endurance. Despite their inability to fly, many penguins migrate considerable distances, cleaving through the water with great speed, alternately diving and leaping with the magnificent grace of a porpoise. At the approach of the nesting season, Adélie Penguins, *Pygoscelis adeliae*, swim to the edge of the Antarctic ice shelf and then trudge many miles inland on foot to the rocky ridges where they nest. At times they lie down and push themselves along on their bellies, sometimes attaining considerable speed as "sleds."

Penguins often jump three to five feet into the air when landing on ocean-swept rocks or ice floes. It is like watching a film of divers in reverse to see a platoon of emperor penguins plummeting out of the water in great arcs to the surface of an ice pan, there to toboggan to a stop and pick themselves up like stocky wrestlers. The emperor penguin also resorts to tobogganing when it walks among snowdrifts—especially if pursued by man.

Penguins are sociable birds both on the breeding grounds and at sea. Their nesting colonies (which may have a population of one hun-

dred thousand) are frequently on the tops of hills near the seacoast or on tiny islands. Well-worn trails or streets lead to the colonies, and the comical little fellows seem to be incessantly scrambling up or down them.

THE PENGUIN'S BREEDING HABITS

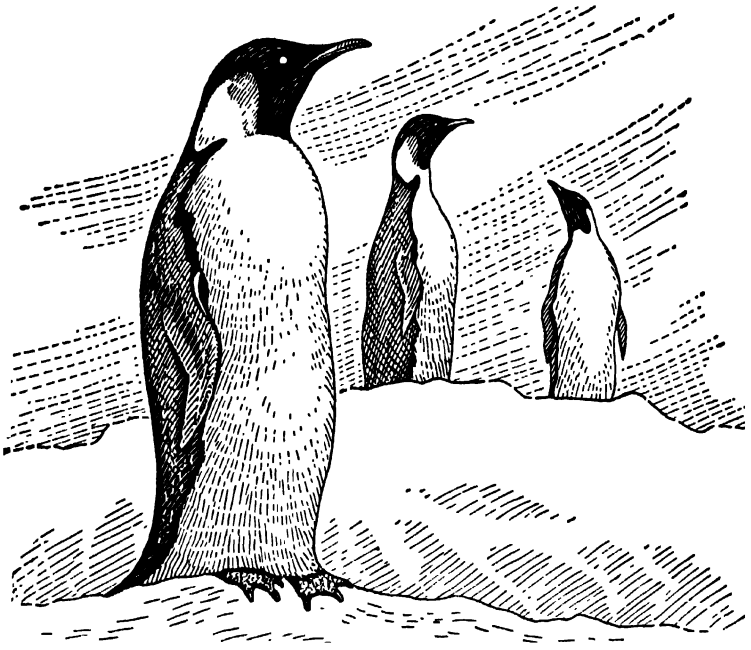
Penguin courtship has one very practical aspect: The male tries to interest a likely mate by presenting pebbles—one at a time—for her inspection. (Penguins use pebbles as foundations to raise the level of their nests as a protection against the melting snows when warmer weather sets in.) Males who lack pebbles will try to steal a supply of them.

The penguin usually fashions its nest of grass and weeds and commonly places it in a hollow or cavity in rocks. Some species nest on the bare ground or ice. Penguins lay white eggs, the number varying from one to three according to the species. Some of the smaller penguins lay eggs that are almost round. The eggs of the larger species taper to one end. Penguins feed their young on fish, squid, or crustaceans (mostly shrimp). The parents predigest the food and regurgitate it, so that the babies may eat it more readily.

The Emperor Penguin, *Aptenodytes forsteri,* the largest of the penguins, has the most southerly range of any bird in the world.

"Amazing" is the word that describes the emperor penguin's habit of nesting during the long Arctic winter. It cradles its lone egg (and later its chick) on its wide feet under a canopy or pouch of loose abdominal skin to shield it from killing temperatures. The adult even manages to move about slowly while carrying the egg on its feet. From time to time it seeks relief from this burden by transferring it to its mate. By the time the young are too big to fit in this pouch, the Antarctic "summer" is at hand and they can survive when left unprotected.

The emperor penguin has a thick cloak of short scalelike feathers. The feathers of the back, wings, and back of the neck are sooty gray with lighter pearly-gray tips. The under parts and sides of the neck are pale golden yellow except on the throat, which, like the face and crown, is jet black. The feet are black, and as for the bill, it is black above, strawberry red below.



A "GIANT" AMONG PENGUINS

The emperor penguin, three feet tall and sometimes weighing ninety pounds, is a giant among penguins. A playful and resourceful creature, it is one of the two kinds of penguins that make their home on the bleak, unfriendly wastes of the Antarctic continent and even manage to flourish there. Unable to fly, penguins waddle, weave, or toboggan on the snow and ice; but they are really in their element in the water.

The Little Blue Penguin, *Eudyptula minor,* is a native of Australia and New Zealand. The smallest member of the penguin family, it just about reaches the size of a small duck. Its feathers are sooty black with grayish-blue tips above, and silvery white below and on the face. The chicks have thick whitish down below and a thick matting of smoky brown down above. They resemble young petrels and, like them, have to depend on their elders for a long time.

The American Jackass Penguin, *Spheniscus,* found mainly on the Falkland Islands, gets its name from its donkey-like bray. This penguin often nests in tunnels up to fifteen feet long.

Loons—Relentless Fish-Hunters

Loons are among the most skillful swimmers and divers of all birds. They are highly adapted for pursuing fish through the water. Their feet are very large and fully webbed and their legs are flattened, enabling them to cut through the water like a knife. They can sink slowly below the surface without leaving a ripple, and can catch fish by outswimming their prey below the surface. Loons are more at home in the water than in the air. Even when pursued by canoe, they prefer to escape by swimming under water. Loons have been caught in fish nets set as deep as 160 or 180 feet below the surface!

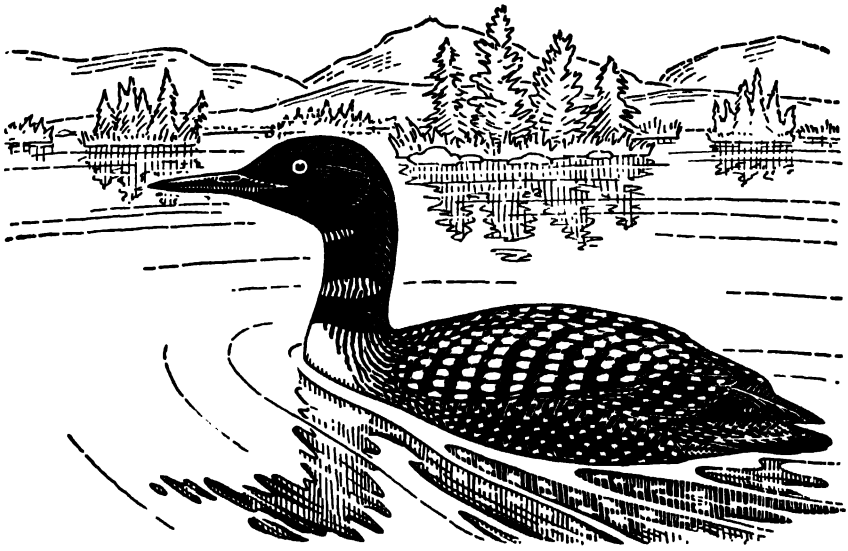
There are only four species of loons—they make up the order Gaviiformes. All of them live in the northern parts of the world. Sometimes they are mistaken for ducks or geese, because of their general resemblance—but they have a heavy, pointed bill and thick neck that mark them off from these fowl.

A striking thing about loons is that their legs are placed far back on the body, like the propeller of a ship. Thus they are unable to walk on land and, like the grebes, push themselves along on their breasts. For the same reason they are unable to take flight from land. When sometimes driven to earth by storms during migratory flights, they are helpless. Such a descent usually means death for them. Even on the water, loons need a long pattering takeoff. However, once they get into the air, they fly strongly.

The loon makes its nest on the shores of a low island or on a muskrat house or other pile of vegetation. Here it lays two mottled, olive-brown eggs. Young loons are covered with down and swim away with their parents as soon as hatched.

The call of the loon resembles prolonged, wild, almost maniacal laughter. Echoing across wild northern lakes, the eerie call conveys much of the spirit of the wilderness.

The Common Loon or Great Northern Diver, *Gavia immer,* nests in Canada and as far south in the United States as northern New York and Michigan; it is also found in northwestern Europe. During the winter and on migrations it is seen in most parts of the United States. At such times the common loon is not shy. As a matter of fact, we once observed a pair of loons that stopped at a lake in Prospect Park in Brooklyn, New York, and remained for more than a week, although at times the lake was almost covered with rowboats.



BIRD OF THE NORTHERN WILDS

Though virtually helpless on land, the loon is a magnificent swimmer and diver—in fact, dives of 150 feet are not at all unusual for it. The loon is so much at home in the water that it can outswim fish, and that is how it gets its living. Sometimes this bird breaks the quiet of the wilderness with its weird call, which reminds us of the exultant laughter of a madman. Pictured above is an adult common loon.

The common loon is a large bird, on an average reaching a length of three feet. It is white below, while its back feathers have a contrasting pattern of black and white check marks. Its head and neck are greenish black, with two incomplete white bands on the neck. The coloring of the male and female is very similar. The male is given to strenuous courting displays—mostly diving and bowing. Young birds have feathers uniformly grayish brown above and white below; the winter plumage of the adults is also of this simple type.

The Yellow-billed Loon, *Gavia adamsi,* is closely related to the common loon. It is an Arctic species that nests in parts of Alaska and northwestern Canada to about the vicinity of Great Slave Lake, and also in northern Asia.

The Red-throated Loon, *Gavia stellata,* and the Black-throated Loon, *Gavia arctica,* are northern species smaller than the common loon. Their popular names give clues to their distinguishing characteristics. When migrating or wintering, the red-throated loon is not uncommon on the larger lakes or sea coasts of the United States. The black-throated loon lives on the west coast south to California. Both species also dwell in the Old World and they nest on some of the Scottish tarns.

Grebes—Accomplished Swimmers and Divers

A REMARKABLE FEATURE of grebe anatomy is that the stomach of one of these birds, of whatever species, invariably contains a ball of its own feathers! Indeed, baby grebes begin to swallow bits of down as soon as they are hatched. Naturalists believe that the feathers may act as a strainer to prevent sharp fishbones from continuing into the intestine.

We find grebes on bodies of water in almost all parts of the world —and this despite the fact that the order they make up (the Colymbiformes, or "divers") contains only twenty species. Like the loons, they excel as divers and swimmers, but are almost helpless on land. Grebes and loons are not, however, closely related. Even their feet are different. The toes of grebes have lobelike flaps, rather than full webs like the loons'. We rarely see grebes in full flight; they usually limit their

migrations to nighttime. Most grebes are very unwilling to take wing, even when pursued.

All grebes have elaborate courtship and mating dances. The Western Grebe, with feet rapidly churning, elevates itself into an erect position with almost its entire body clear of the water. In this position it patters along the surface for several yards. The Great Crested Grebe has a similar water-treading performance in which a pair of birds face each other as in a dance. At times they carry around bits of waterweed in their bills during these dances; this has a symbolic connection with nest building. In the nesting season grebes have a variety of call notes; in the winter they are invariably silent.

Grebes are not good to eat but duck hunters sometimes shoot them by mistake. The birds often escape by diving and hiding.

The Horned Grebe, *Colymbus auritus* ("eared"), dives so rapidly that country boys call it the "Hell-diver." In the old days of black powder it could dive at the flash of a gun before the shot reached it. The horned grebe, which is a little over twelve inches long, is the best-known American species; it is also found in the Old World, where it is known as the Slavonian Grebe.

During the nesting season the horned grebe prefers northern territory, but it is common in the United States as a migrant or winter visitor. At that season its coloring is plain, gray above and white below. Before departing for its nesting grounds in the spring, the horned grebe molts into its handsome breeding plumage. Its head is then black, with conspicuous buffy tufts of feathers on the sides; the neck and the sides of the body turn reddish.

——RELATIVES OF THE HORNED GREBE. The Eared Grebe, *Colymbus nigricollis* ("black-neck"), of western North America, resembles the horned grebe but can be distinguished in breeding plumage by its black neck. In winter plumage the two can be told apart only by an expert.

The Holboell or Red-necked Grebe, *Colymbus grisegena* ("gray cheeks"), is a larger related species with a thicker neck and grayish-white cheeks. Like most members of the grebe family, it builds its nest in shallow water. The red-necked grebe nests in the Northwest, chiefly in Canada, and has recently begun to nest on the shores of Lake Ontario near Toronto, Canada.

The Great Crested Grebe, *Colymbus cristatus,* another related spe-

cies, is found only in the Eastern Hemisphere, where it ranges from England to New Zealand. The feathered "ears" of the smaller grebes are magnified in this species into large tufts of feathers or "tippets," formerly used to adorn hats.

The Western or Swan-Grebe, *Aechmophorus occidentalis,* is about twenty-nine inches long—the largest and most graceful American grebe. Its color pattern—black above and white below—is simple, but the long thin neck and graceful outlines enhance its beauty. Formerly the western grebe was a victim of plume hunters who prized its feathers.

The Pied-billed Grebe, *Podilymbus podiceps,* is common in the United States, and prefers ponds covered with water lilies and other vegetation. Although most grebes have sharp-pointed bills, the beak of the little pied-billed grebe is more or less chickenlike in shape and is encircled by a black band.

The eggs of the pied-billed grebe, like those of all the other members of the family, are buffy white, but soon become discolored by the dampness of the nest. The mother covers the five or six eggs with nesting material whenever she leaves the nest. If one of the eggs happens to roll out of the shallow nest, she rolls it back with her bill.

When the young grebes hatch, they are covered with down and boldly marked with black stripes. The first young to hatch enter the water soon, following their father. When they get cold or tired they clamber beneath his wings and from there climb onto his back. Meanwhile the mother continues to incubate the other eggs, as it may take several days for all of them to hatch.

A larger species related to the pied-billed grebes but almost flightless is found only on Lake Aititlan in Guatemala. Lake Titicaca, high in the Andes of Bolivia, is the home of a truly flightless grebe.

The Mexican Grebe or Dab-Chick, *Poliocephalus dominicus,* a bird scarcely half the size of a small duck, ranges as far north as the southwestern border of the United States. Professor Alfred Gross recently studied a pair of the Cuban race of this grebe and found that during the course of a single year the female laid eight sets of eggs totaling thirty-five eggs. Twenty-four young were raised. This repeated mating is surprising, since most water birds lay only one clutch of eggs per year.

Albatrosses and Their Relatives—Denizens of Lonely Seas

THE BIRDS of this order have an amazing range of body size. At one end of the scale there is the Wandering Albatross with a wingspread of twelve feet; at the other end are the storm petrels—no bigger than robins! All these birds of the order Procellariiformes have a bill covered with horny plates. They are sea birds that come to land only to nest. All the species lay no more than a single egg. Both parents incubate; one may sit on the egg constantly for as long as a week, while its mate is at sea. Then they change roles.

Petrels and albatrosses are primarily birds of the Southern Hemisphere. They swarm in such turbulent cold seas as those about Cape Horn.

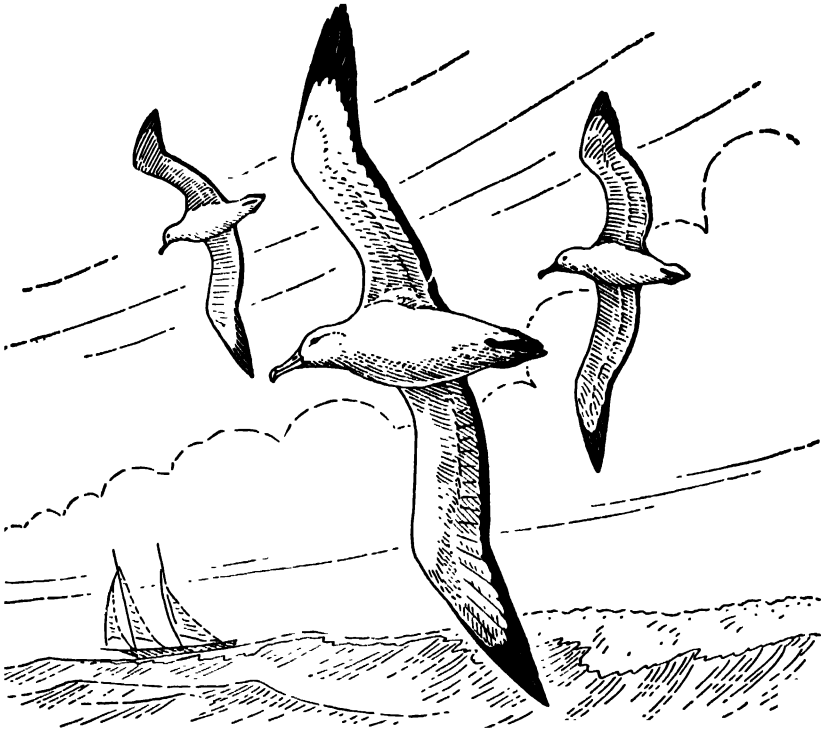
ALBATROSSES—FABULOUS FLYING BIRDS

These remarkable birds spend most of their lives on remote ocean wastes. Everyone who has read Coleridge's *Rime of the Ancient Mariner* is familiar with the fabled albatross, a name applied to all the thirteen species of the family Diomedeidae. One of them, the Wandering Albatross, *Diomedea exulans,* has the greatest wingspread of any bird.

The albatross is stout of body and has a large head. It has a small tail and amazingly long narrow wings. For hours at a time the albatross can glide effortlessly, keeping its wings nearly motionless. This technique has recently been copied by builders and pilots of the highly specialized gliders known as sail planes. In aerodynamics the term "sailing" is applied to it.

What is the secret of the albatross's smooth and easy glide? It tacks

across the wind on a rising course. Then it glides down in a rapid arc, first with, then against, the wind, into the ever-present semistatic cushion of air lying just above the ocean surface. Cleaving into this cushion at the great speed it has gained from its downwind descent in mobile air, the albatross achieves a violent impact or bounce. This shoots it aloft again to tack across the wind. All this happens without recourse to wingbeats! In periods of calm the albatross flaps its wings—else it must rest on the ocean.



MOLLYMAWK AND GOONY BIRD

These are some of the names sailors have for the albatross, that phenomenal flier of the trackless oceans. Outstanding in the group is the wandering albatross, with the greatest wingspread (twelve feet from tip to tip) of any bird. Like others of its kind, it spends its whole life at sea, coming to land only to breed.

The chief characteristic of the albatross, apart from its unusual mode of flight and its great size, is its stout hooked bill. Covered with horny plates, this bill contains tubelike nostrils which lie along the

upper part of the bill. Mollymawks, giny or goony birds, as albatrosses are sometimes called, are usually white; but a few are brown or gray. They feed on cuttlefish and a variety of small sea animals snatched up chiefly at night from the surface of the ocean.

Like their near-relatives, the petrels, some albatrosses follow ships for extended periods. They are apparently drawn to the vessels by garbage scattered in their wake. In retrieving refuse, the albatross settles lightly on a wave top, its wings half open and elevated, or furled and carried high on the back. Sailors have long amused themselves by catching albatrosses. They do this by dragging a baited hook in the wake of a ship. There is a strong taboo, however, against killing the birds; they are thought to bring good luck.

In taking off, the albatross sprints briskly on the water with its webbed feet, flapping its wings jerkily. On land, it is exceedingly clumsy. To take flight it needs a considerable stretch of runway. Birds freed on the deck of a ship cannot take off over the rail.

There is hardly a sailor who does not have a ready supply of stories about albatrosses that have followed his ship time and again across vast stretches of the southern oceans. At night the ship-followers apparently settle on the water to feed. Occasionally one of them can be recognized by some peculiarity of plumage. But what trustworthy reports we possess show that albatrosses do not stay with a ship for more than a few days. That is why most naturalists have concluded that the majority of the amazing distance flights credited to these birds belong in the realm of folklore.

Still, certain remarkable records remain. For example, an adult albatross banded at Kerguelen (an island in the Indian Ocean) in 1914 was retaken in 1917 near Cape Horn, some six thousand miles away. There is no evidence that the bird followed a ship.

WHERE WE FIND THE ALBATROSS

Nine of the thirteen kinds of albatrosses range outward from ancestral breeding places on small islands in the southern oceans. They are found from the Antarctic ice northward to about 60° south latitude. Several species wander into the tropics in areas cooled by the Humboldt Current. One species, the Waved Albatross, *Diomedea irrorata,* breeds near the equator in the Galápagos Archipelago. Three species are birds of the North Pacific.

In the wake of tropical hurricanes southern species occasionally appear in the North Atlantic. On the heels of the great hurricane of 1938 along the east coast of the United States, observers reported sighting the Yellow-nosed Albatross, *Diomedea chlororhynchos,* over Long Island in New York. Other stragglers of this species have been seen over the Gulf of St. Lawrence and near Seal Island, Maine.

In years past, Japanese hunters plundered breeding grounds of the albatross in the North Pacific. Before this practice could be stopped, one species, the Short-tailed Albatross, *Diomedea albatrus,* was exterminated.

COURTSHIP AMONG THE ALBATROSSES

Midway Island in the Central Pacific is the home of the Laysan Albatross, *Diomedea immutabilis,* and the Black-footed Albatross, *Diomedea nigripes.* Servicemen in World War II brought back interesting tales about these birds. When nesting, the albatrosses were often observed carrying out their domestic tasks within a few feet of crowded military installations. They were methodically directed some distance from runways, not infrequently with a GI porter detailed to convey the egg to the nearest safe area.

Nuptial dances of albatrosses are as curious as they are amusing. The birds grunt, cry, and waddle stiffly about, rubbing bills, bowing, preening, and posing with bill aloft. The female lays a single chalky egg on the ground. The parents feed the young by regurgitating predigested food. It does not take the offspring long to become big and fat. Several months must pass, however, before they take to the open sea. After the nesting season the black-footed albatross wanders to the North American coast.

PETRELS AND THEIR RELATIVES—MYSTERIOUS MARINE BIRDS

The fifty-seven varieties of petrels, shearwaters, and fulmars differ from their relatives by the arrangement of the horny plates on the bill. There is quite a bit of variety in this family. One species, the Giant Petrel, *Macronectes giganteus,* has a wingspread of twenty inches and approaches the smaller albatrosses in size. On the other

hand, the Thin-billed Prion, *Pachyptila belcheri,* is hardly larger than a robin.

The plumage of this family (the Procellariidae) is on the somber side, tending to gray, brown, and dull white or an assortment of these colors. Their bill and feet are usually gray or black, sometimes pinkish or bluish. The color of the plumage is no clue to sex, as it is in many birds. The young resemble their parents.

These birds fly in much the same way as the albatross, but they flap their wings more often. The Fluttering Shearwater, *Puffinus gavia,* of the Southwest Pacific, flaps its wings almost incessantly.

Many petrels are similar in color and size. Nevertheless we can distinguish a goodly number, among them the giant petrel previously mentioned. Sailors recognize only a few main types. They call the giant petrel "Nelly" or "Cape hen." Prions, a group of much smaller petrels, are called "ice birds," or "whale birds," and shearwaters are known as "mutton-birds."

Petrels frequent all the oceans of the world, but nowhere else are there the vast numbers that are found in Antarctic seas. Many species remain continuously at sea for periods of more than six months.

Once a year, for about three months, petrels come to land to nest, usually on remote islands. The female lays a single white egg in a shallow burrow, or on the ground in low vegetation, or among rocks. The Snowy Petrel, *Pagodroma nivea,* flies many miles in from the ocean to nest on the desolate mountain ranges of the Antarctic continent.

By day, nesting petrels are silent. Both sexes take part in brooding, sitting quietly one at a time in the musky tunnels on sparse nests of grass and feathers while the mate hunts far out at sea. A crescendo of strange cries breaks forth from the hidden brooders at dusk when their mates return en masse from the sea.

The young become very fat and fluffy. They remain in the nest for many weeks and are fed by their parents' regurgitation of an oily fluid made up of sea organisms.

Because of their marine existence, we know less about petrels than we do about most other birds. The breeding grounds of several species remain undiscovered. An immature petrel of one species, the Bermuda Cahow, *Pterodroma cahow,* was recently picked up dead in a Bermuda street following a storm—more than a quarter of a century after the species had been considered extinct! Soon after this inci-

dent, Bermudan cahows were discovered alive. This aroused great interest on the island, the bird becoming virtually a patriotic symbol.

The commonest oceanic bird in many northern seas, and the one which has the most marked preference for group living, is the Fulmar, *Fulmarus glacialis.* This petrel nests on the coasts and islands of both the North Atlantic and the North Pacific. The bird is about nineteen inches long, has gray and white coloring, and spews out a foul-smelling oily mixture at any intruders that turn up at its nesting grounds.

Superbly equipped to live at sea, petrels are pitifully vulnerable on land. Their extermination becomes as good as certain whenever cats are introduced on an island where the birds breed. One species, the Jamaica Petrel, *Pterodroma jamaicensis,* was exterminated in this way. Rats also wreak havoc on petrel colonies, although a few of the larger species may be able to ward them off. The giant petrel is an exception. It kills and eats young penguins and is quite capable of protecting its own egg or young.

"WATER-WALKING" STORM PETRELS

These small, swallow-sized birds are often miscalled "stormy petrels." The term has become a figure of speech used to describe people who go out of their way to look for trouble. The birds flit above the ocean surface, incessantly pattering along the water with their webbed feet and undulating in cadence with the waves. Like St. Peter in the Bible, these birds have the apparent ability of walking on water; hence the name "petrel." (The scientific name of the family, Hydrobatidae, means "water-walkers.")

It is the storm petrels' batlike flight that chiefly separates them from their larger relatives. Storm petrels use their legs continuously in aerial maneuvering. However, the legs are so thin and specialized that the birds cannot walk on land without using their wings as crutches.

The twenty-one species are plain-colored birds, with gray, black, and white predominating. As for nesting habits, storm petrels differ little from the petrels, shearwaters, and fulmars. There is one exception—the storm petrel's egg is apt not to be just plain white, being flecked with black or reddish spots around the larger end.

At times, great flocks of these birds are attracted to oily refuse

scattered in the wake of whaling vessels; but normally storm petrels feed on small sea organisms.

The Least Storm Petrel, *Halycyptena microsoma,* is the smallest oceanic bird known and the only member of the family with a wedge tail. It ranges along the Pacific coast of North America to tropical America from breeding grounds on San Benito Island off Baja California.

Wilson's Storm Petrel, *Oceanites wilsoni,* is the most familiar and wide-ranging species. These petrels have the familiar nickname "Mother Carey's chickens." The term "Mother Carey," according to some authorities, is a form of *Mater cara* ("dear mother"), invoked by sailors facing disaster at sea. Another version is that Mother Carey is the wife of Davy Jones, to whom the bodies of those lost at sea find their way.

Wilson's storm petrel nests on Antarctic islands from December to March, and the young often freeze to death even though this is summertime in the Southern Hemisphere. At the approach of the Southern Hemisphere winter this petrel migrates north. During June and July it is common in the North Atlantic, appearing even in New York Bay. The bird feeds on oily fish wastes, and is often found in the wake of ships.

Leach's Petrel, *Oceanodroma leucorhoa,* nests on the North Atlantic coast. It digs a burrow in which to nest and spends the day either in its burrow or far out at sea. Whenever storm petrels are driven from their burrows in the daytime they are killed in large numbers by gulls, skuas, and other marauders. We once spent a night in a colony of Leach's petrels and were amazed at the activity pervading the area after nightfall. Myriads of the noisy birds flew about. At dawn the area lapsed into silence.

DIVING PETRELS

Diving petrels breed on small islands ringing Antarctica. Their nesting habits are much like those of other petrels, and rock crevices are their favorite nesting places. They are partial to coastal waters, where they are usually seen in flocks. Excellent divers, they swim under water, using their wings as well as their feet. We have reports that on occasion they burst out of the sea in full flight or fly effortlessly through a comber.

The species of this family (Pelecanoidinae) found nearest American shores is the Peruvian Diving Petrel, *Pelecanoides garnoti,* which restricts itself to the cold water of the Humboldt Current along the Pacific coast of South America. Diving petrels have short wings and closely resemble the small auks and dovekies of northern seas in appearance and habits.

Pelicans, Cormorants, Snakebirds, Boobies, Man-o'-War Birds, and Tropic Birds

THIS ORDER is made up of birds that frequent the sea or inland waters. These birds have completely webbed feet. Even the hind toes are included in the web and are not free as in ducks. A chalky deposit covers the eggs; an exception in this respect is the tropic bird, the least typical member of the order (Pelecaniformes). The bill, usually of medium length, is strongly hooked.

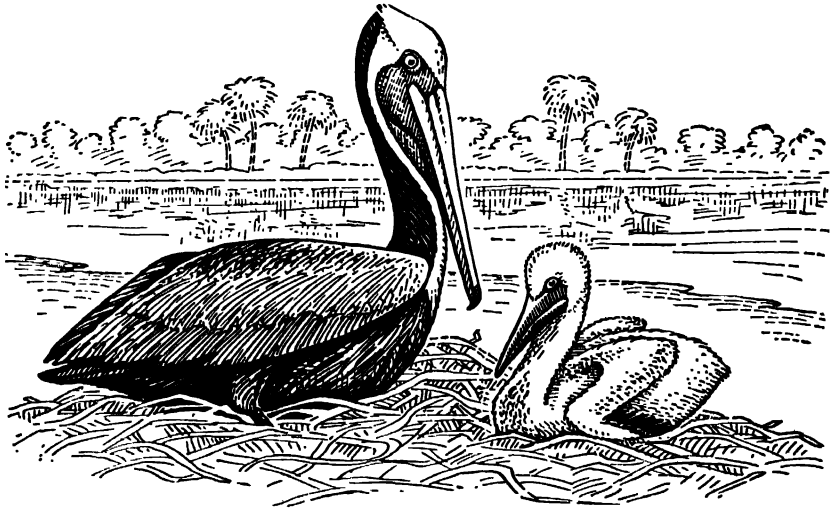
The young, when full grown but still unable to fly, are abandoned by their parents. It may be a matter of weeks before they learn to fly well enough to get their own food. During this stage they live on their own fat and lose considerable weight.

PELICANS AND THEIR STRANGE FEEDING METHODS

Everyone recognizes these large, heavy-set water birds. They are generally about five feet in length and have a wingspread of from six to nine feet. The pelican's bill is a foot or more long, and beneath this bill hangs the pouch that is the bird's chief claim to fame. The pouch is made of elastic skin and is hardly noticeable when empty. The pelican plunges with open bill into a school of small fish. The

pouch serves as a scoop, taking in the fish and often several quarts of water as well. When the bird comes to the surface the water runs out the sides of the bill and the fish are gulped down. They are never stored in the pouch.

The Brown Pelican, *Pelecanus occidentalis,* is common on the coast of Florida, the Gulf States, California, and South America. The brown pelican catches fish by diving into the water and engulfing them in its pouch. On rare occasions it has been known to drive into its pouch a large fish that it could neither swallow nor disgorge, so causing its own death.



THE PELICAN—UGLY BUT INTERESTING

The pelican is among the largest of all birds; a five-foot length and a seven-foot wingspread are not unusual for it. Spectacular as the long bill is, the large pouch under it is even more remarkable. The pelican makes good use of the pouch when it feeds under water, and also when it serves a meal to its youngsters—they probe in the pouch for predigested tidbits. Pictured above is the brown pelican.

Brown pelicans often live in a semitame state in the harbors of Gulf coast towns. In Florida they have a sanctuary on Pelican Island, which shelters some two thousand of these birds.

The White Pelican, *Pelecanus erythrorhynchus,* is the other American species. One of the largest birds found in North America, it lives in the interior, nesting chiefly on islands in desert lakes such as the

Great Salt Lake in Utah. Although it is very ponderous, it can soar for hours once it is aloft. During migrations, it is occasionally seen on the coast southward from Long Island in New York. It is not uncommon in Florida in wintertime.

Like all pelicans, the white pelican nests in colonies and lays three or four eggs which are heavily covered with a chalky deposit. The young are naked and ugly when hatched. When partly grown, they gather into little flocks, called "pods," which cruise along the shore. When the parents arrive with food, the young pelicans push their bills far down into the older birds' pouches. They penetrate so far, indeed, that this habit gave rise to an old legend that they feed on blood.

The white pelican does not dive after fish, but swims about in a school of small fish, scooping up as many as possible in its roomy bill and pouch.

There are five species of Old World pelicans and their habits and appearance are very similar to those of New World pelicans. The pelican family is called "Pelecanidae."

CORMORANTS AND THEIR IMMENSE VALUE TO MAN

Since ancient times the Common Cormorant, *Phalacrocorax carbo,* and the Japanese Cormorant, *Phalacrocorax capillatus,* have been trained to assist the fishermen of India, China, Japan, and England. Indeed, fishing with the aid of cormorants was once a widely practiced sport in England, with the Master of the Cormorants serving as an officer in the royal household.

Of the twenty-nine species of cormorants making up the family Phalacrocoracidae, six have been taken in the New World. Cormorants are usually black, with long necks and relatively long wings. They are large birds—about three feet in length. In the main, they live along seacoasts (their name originally meant "sea raven"). However, certain species frequent inland waters—ponds, streams, and rivers. Cormorants resemble ducks and geese in size and in their manner of flying in loose waves and V's, but, unlike these birds, they frequently interrupt their wingbeats to glide. They have slender, sharply hooked bills, and often the bare skin of the face and throat is gaudily colored.

CORMORANTS PREY ON FISH

For centuries the cormorant has been notorious as a symbol for greediness. Shakespeare used the symbol in his phrase, "cormorant, devouring Time," where the name of the bird becomes an adjective. Fishermen consider the cormorant or "shag," as they usually call it, a destructive bird because it has a voracious appetite for fish. Most of the fish it takes are, however, worthless species, as far as man is concerned.

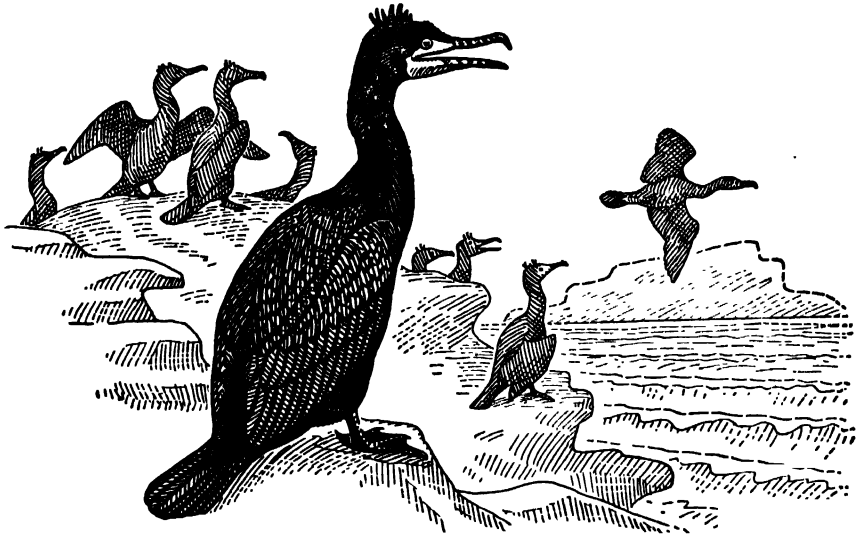
In the Far East, where six or more birds are sometimes used simultaneously for fishing, resting cormorants are kept hooded, and a loose collar is placed around their shaggy necks. The collar prevents the cormorant from swallowing captured fish, while the blind or hood keeps the bird quiet during periods of inactivity. The fishing is done at night, by the light of colorful flares or torches.

Cormorants usually swim with their feet. Sometimes they use their wings also, whipping and turning with the greatest of ease in pursuit of their prey.

As a rule, cormorants nest in colonies, on the bare ground, on rocks, or in trees. A tree nest is built of sticks. On land it usually consists of seaweed and guano scraped haphazardly together. (The word "guano" is derived from the Inca *huanu*—"dung.") Cormorants lay two to four oval, chalky, bluish eggs. The ugly black young hatch out in about four weeks. As among the pelicans, the young feed by thrusting their bills down the parent's throat.

Colonies often contain many thousands of birds and the quantity of guano which accumulates in the nesting area over the centuries is occasionally phenomenal, particularly in such arid places as the bird islands of Peru.

The White-breasted Guanay or Peruvian Cormorant, ***Phalacrocorax bougainvillei,*** of the Peruvian bird islands, is one of the chief producers of guano fertilizer and is therefore sometimes said to be the most valuable wild bird in the world. Appreciating the fact that the guano industry is a million-dollar business, the Peruvian government now protects these cormorants very strictly. Unlike other cormorants, the guanay dives from the air directly into the ocean after fish.



THE DOUBLE-CRESTED CORMORANT

This bird nests over most of the North American continent, both on rocky coasts, as shown here, and on inland lakes. Sometimes it makes its nest on a rock; sometimes it selects the branches of a tree. Note the long neck, the webbed feet, and the hooked bill of this creature. Cormorants are famed for their skill as fishermen.

GUANO—MORE PRECIOUS THAN INCA GOLD

As a fertilizer, guano is thirty times more effective than ordinary farmyard manure. The Incas were well aware of this, and they brought guano in ships from the bird islands to the mainland. This enabled them to raise flourishing crops on hillsides that would otherwise have remained bare. It has been well said that the guano was more precious than the fabled gold that excited the cupidity of the Conquistadors.

The story of these guano deposits is a fascinating one. The Humboldt Current is a cold-water current that extends northward along the west coast of South America from the Antarctic regions to the vicinity of the equator. The low temperature favors the formation of mineral salts and nitrogen compounds. This results in a huge quantity of minute vegetation on the ocean floor, supporting fantastic numbers of organisms that feed on the plants, fishes that feed on the organisms, and cormorants and other birds that prey on the fishes.

The small islands off the west coast are crowded with millions of cormorants, boobies, and pelicans—the culmination of this cycle.

What makes the guano so effective, then, is the fact that it contains the ingredients which originate in the sea as the consequence of the low temperatures produced by the Humboldt Current. Over the centuries there have accumulated huge heaps of hardened guano as much as a hundred feet thick.

But the Humboldt Current plays an important role in another way. Under normal rainfall conditions, the guano heaps would have been washed away in time. However, the low temperature of the water keeps the coastal breezes so cool that rain becomes impossible. (Ordinarily rain is the result of warm air rising to meet cold air and thus condensing into water vapor.)

About once in seven years a warm-water current comes south from the tropics and temporarily deflects the Humboldt Current. When this happens, there is a destructive amount of erosion, guano is washed away, and thousands of birds starve. But then the Humboldt Current resumes its sway and the long-term trend, leading to the formation of more and more guano, is renewed.

OTHER CORMORANTS

The Galápagos Cormorant, *Nannopterum harrisi*, is a remarkable member of the cormorant family—it is flightless. Though a large bird, it has very small wings, and the feathers, like those of many other flightless birds, are rather hairlike and soft.

The Common Cormorant, *Phalacrocorax carbo* ("black"), is almost wholly black. In the breeding plumage slender white plumes appear on its throat, flanks, and neck. This cormorant is almost the size of a goose. It is a regular visitor to the shores of Long Island in New York from northern breeding islands. Percé Rock in the Gulf of St. Lawrence is probably the most famous of these islands. The common cormorant is also a familiar figure on European coasts.

SNAKEBIRDS AND THEIR REMARKABLE FISH-SPEARING TECHNIQUE

Snakebirds resemble cormorants and are closely related to them; but the snakebird has a greatly elongated neck that enables it to spear

fish under water with great facility. The snakebird is able to do this because it has extra vertebrae—small bony segments in the neck—which make it possible to coil the neck back upon itself and then release it with viper-like speed. This trait gives the snakebird its name. Another reason for the name is that the bird occasionally swims with all but its head submerged. At such times it resembles a water snake.

Snakebirds (variously called anhingas, water turkeys, or darters) are blackish birds of quiet inland waterways throughout the warmer regions of the world. All the anhingas are so closely related that they fall within a single genus, *Anhinga*, containing four very similar species—one each in Africa, southern Asia, Australia, and the Americas. This is the sole genus of the family Anhingidae.

The American Snakebird, *Anhinga anhinga,* has been known to nest as far north as North Carolina. It attains a length of up to thirty-four inches and has webbed feet. Fish and other water animals make up its diet.

This bird breeds in bushes above water. Males are glossy greenish black with stiff feathers adhering tightly to the body. Across part of its back and wings are silvery-gray markings, and the proportionately long fantail is banded with brown and tipped with gray. The tail feathers have curious corrugations found in no other bird.

In summer, males display a handsome mane of pale grayish plumes. The female snakebird is browner, and a reddish band separates the breast from the abdomen. The baby anhinga emerges from the shell completely naked but soon takes on a covering of brownish down.

One of the clumsiest exhibitions of bird flight we have ever seen was given by a Panamanian snakebird. It was perched on a high snag over Gatun Lake. As we slowly drew nearer and nearer, paddling in a *cayuco,* or native dugout, the bird hobbled about, opening its wings and then partly closing them and letting them droop below its perch. It appeared so hesitant that we thought it was actually afraid to fly. Yet, when we approached closely, to our surprise the bird sailed off with apparent ease.

THE GUILELESS GANNETS AND BOOBIES

The boobies received their name because they stupidly permit themselves to be captured while asleep. The same is true of the Northern

Gannet, *Morus bassanus;* we once succeeded in seizing a sleeping bird by hand.

Gannets and boobies make up a family (the Sulidae) containing ten species of long-winged sea birds, the size of small geese. Boobies live in the tropics, gannets in temperate regions. The boobies of the Bahamas are said to have indicated to Columbus the approach of land on his famous voyage of discovery.

Boobies and gannets dive upon fish from high in the air, plummeting into the sea from heights of sixty to one hundred feet, trailing their wings awkwardly. Gannets sometimes pursue fish to a depth of ninety feet below the surface (they have been taken in nets anchored at that depth). The name "gannet," by the way, originally meant "seafowl," and it is related to the more familiar word "gander."

The most valuable member of the family is the Peruvian Booby or Piquero, *Sula variegata.* It is one of the more important producers of guano.

WHERE THEY LIVE

The boobies nest on small oceanic islands, usually close above the water. The northern gannet is migratory and is a familiar bird off the eastern tip of Long Island in New York during the months of October and March. Southern species, such as the Red-footed Booby, *Sula sula,* nest on little islands in the Caribbean and on other islands ringing the globe in the tropics. They are apt to breed at any time of the year.

The North Atlantic is fringed with "gannetries" (breeding grounds). The best known of these in the New World are Bonaventure Island and Bird Rock in the Gulf of St. Lawrence. In Europe the most famous colony is on Bass Rock, off the coast of Scotland. The species name, *bassanus,* refers to this rock. During summer months the gannets gather about these islands to breed on cliff ledges.

In 1936, while searching the northern coasts of Newfoundland for remains of the extinct great auk, we came upon a flock of five breeding gannets on Funk Island. This was an exceptionally interesting discovery—until then the gannet had been known to breed on only four islands in the New World, and Funk Island was not one of them. Since that date a sixth colony has been found in southern New-

foundland. It would seem that wanderers from the well-protected breeding grounds in the Gulf of St. Lawrence are establishing additional gannetries on the Newfoundland coasts.

THE NESTING HABITS OF GANNETS

In recent years many persons have visited Bonaventure to observe the nesting gannets. These birds are white, with a buffy wash on the back of the head, black primaries (large flight feathers of the wing), and a light gray bill and slaty throat. In April the birds pair, and a short time later they build moundlike nests of seaweed. They place the nests two or three feet apart, and each bird defends its area, vigorously and vociferously, against all comers. The adults jab and parry with their long conelike bills at any intruder in order to retain ownership of their territory.

The gannet lays a single light-bluish egg; some boobies lay a clutch of two or three. The brooding period is forty-two days. Naked when hatched, the young quickly grow a cloak of white down.

The adult feeds its young by regurgitation—a process sometimes frightening to watch. Opening its great bill, the adult distends the naked yellow skin of its chin, and usually curls its great head backward along the side of its body. The tiny naked chick manages to climb into its mother's throat for food. This operation often continues for many minutes as the adult writhes and gulps. Its problem is to heave up a respectable piece of fish for its charge without flushing the eager little fellow backward in an aromatic stream of half-digested fish.

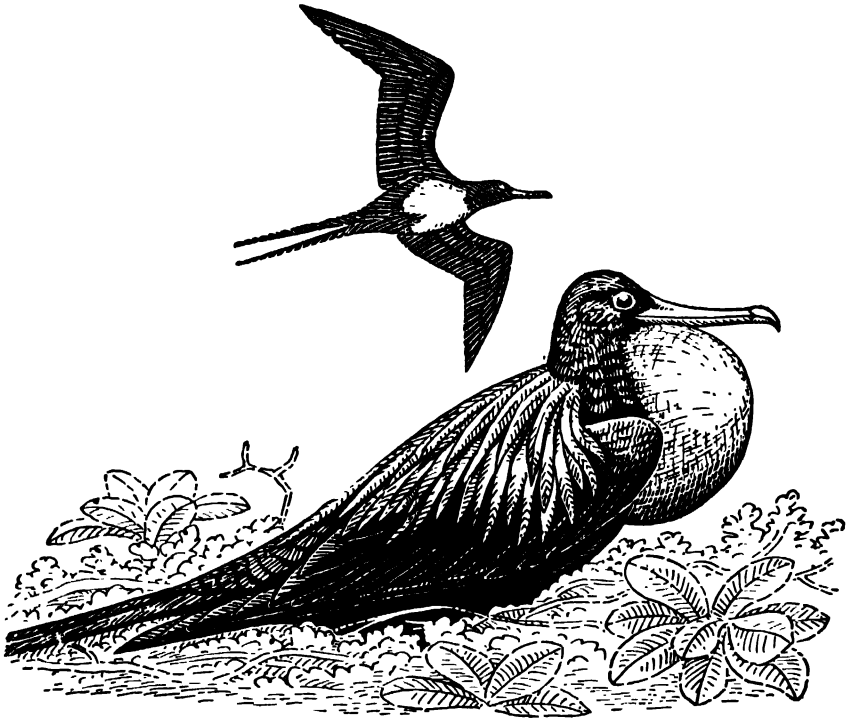
In less than a month, the young become covered with gray-brown feathers. This immature dress they keep for most of the next three years.

MAN-O'-WAR BIRDS—PIRATES OF THE AIR

This bird probably gets its curious name from its highly aggressive character. It pursues boobies, terns, and other fishing birds and forces them to drop or disgorge fish they have caught. Then it deftly seizes the falling fish in mid-air. At times it swoops low enough to snatch young terns from the ground or fish from the surface of the water—though it never alights on the sea. When flying fish take to the air

to escape larger fish, they are often caught in mid-air by a man-o'-war bird!

As you may have guessed from this description of its feeding habits, the man-o'-war bird is magnificently equipped for flying. Its wings are tremendously long (6-foot wingspread) and pointed. Its long forked tail acts as an efficient rudder in flight. When seen in the air, the bird looks like a gigantic swallow. In proportion to its size, it has a greater wingspread than any other bird.



THE MAN-O'-WAR BIRD—BOLD UP TO A POINT

The male man-o'-war bird (*bottom*) has a brilliant, formidable-looking scarlet throat pouch that is inflated when this creature is courting. Often this freebooter of the air makes off with another bird's fish before its neighbor has a chance to devour the prey. For all that, the male man-o'-war bird allows himself to be henpecked by the female (*top*). This bird is outstanding in a family of superb fliers.

Man-o'-war birds (also known as frigate birds) are found on tropical seacoasts and small islands throughout the world. Though related to the pelicans, they have an entirely different appearance be-

cause of their flying adaptation. The man-o'-war bird has very small legs and feet. It is almost helpless on land and surprisingly enough (since it is a seafowl) on the water as well.

The five species of this family (the Fregatidae) are all bluish or greenish black. In young birds, and sometimes the adult females, the head or even the entire lower parts are white. The males have a bright scarlet gular (throat) pouch. During the breeding season, when the males sit in bushes on the nesting grounds, they inflate this pouch with air like a balloon. Presumably this brilliant red ornament helps them secure a mate or scare off rival males. The female man-o'-war bird is larger than her mate. The male is said to perform the larger share of brooding and taking care of the nestling.

Man-o'-war birds make their nests of sticks snatched from the ground or broken from bushes during flight. They place the nests on top of bushes or rocks. The female lays only a single white egg.

The Magnificent Man-o'-war Bird, *Fregata magnificens,* is not uncommon in southern Florida and, following hurricanes, individuals are occasionally seen as far north as New York. Despite their superb flying ability, it seems that man-o'-war birds never venture more than about seventy-five miles from land.

During World War II, while stationed near Koko Head, a volcanic peak on the coast a few miles above Honolulu, Hawaii, we used to see a flock of fifteen or so Frigate Birds, *Fregata minor,* each evening. It was their habit to soar about before going to roost on Mokumanu, an offshore islet. We were struck most of all by the skillful way they used their long tails in maneuvering in the air; they often opened and closed them like a fan.

THE GRACEFUL TROPIC BIRDS

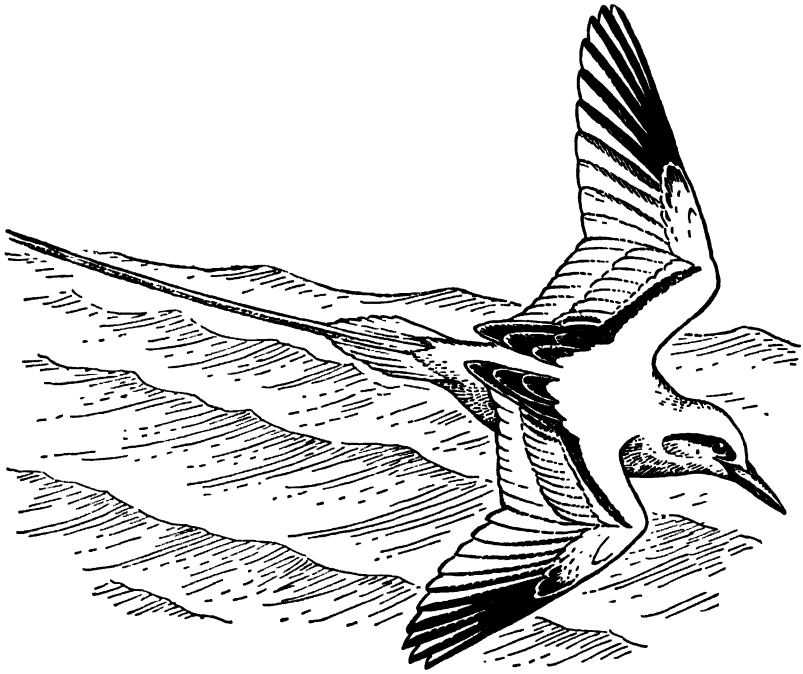
Tropic birds are graceful white birds with satin-like plumage. As their name indicates, they inhabit tropical oceans. The three species of the family Phaëthontidae are about thirty inches long. Hardly bigger than pigeons, their long slender wings and greatly elongated tail feathers make them appear larger.

It was the famous eighteenth-century scientist Linnaeus who gave these birds the name "Phaëthon" (the charioteer of the sun). He had in mind their range over the sun-bathed tropics. Sailors call them "boatswain birds," possibly because of their rolling gait on land. An-

other theory is that the bird has a shrill cry reminiscent of a bosun's whistle.

WHERE WE FIND TROPIC BIRDS

Tropic birds rarely stray from the tropics; but after a hurricane, one is occasionally seen off the coast of Long Island in New York. Within their customary latitudes they rove over great distances on the ocean. A list of their breeding islets reads like an index to the most remote and mysterious of South Sea islands.



BOATSWAIN BIRD

This is the sailor's name for the silky-plumaged tropic bird, one of the most beautiful birds of the tropics. The nickname is supposed to be based on the bird's rolling gait, or on its shrill call. In flight its long wings and long tail feathers create an extraordinarily graceful effect. This creature is hardly larger than a pigeon.

The breeding places of the Red-tailed Tropic Bird, *Phaëthon rubricauda,* include Mauritius (former home of the dodo) in the Indian Ocean, Christmas Island in the South Pacific, islands in the Torres Strait, Lord Howe, Norfolk, the Hawaiian Islands, and even

Iwo Jima—to mention a few. The red-tailed tropic bird is silky white, often with a tinge of coral and a red bill. It gets its name from the central pair of red, greatly elongated tail feathers.

The Yellow-billed (or White-tailed) Tropic Bird, *Phaëthon lepturus,* is found in the Bermudas, Bahamas, and the West Indies. This species also nests on cliffs on Pacific islands, and we have watched them floating about like white specks near their nests on the walls of the tremendous volcanic craters of Hawaii.

THE HABITS OF TROPIC BIRDS

Tropic birds have an easy, wheeling flight, and the long tail plumes enhance their graceful appearance. On occasion, an ardent bird flying close above its mate will point its tail downward so that the long tips touch the lower bird.

Though rather helpless on land, tropic birds float buoyantly on water, their tails tilted rakishly upward. They feed on small fish and squid, which they catch by shallow diving. These birds differ from all their relatives in that the single egg is red, not white, and the newly hatched young are downy, not naked.

The natives in the South Pacific region still collect the tropic bird's brilliant feathers in small numbers. Commercial feather collecting has been largely stopped, and we now have reason to believe that the tropic birds will be able to hold their own in many areas. The introduction of house cats and Norway rats spells quick doom to tropic birds—perhaps for the paradoxical reason that they defend their nests and their young with a kind of blind bravery, and so fall victims themselves.

Herons, Storks, and Ibises

MOST OF THE BIRDS in this order are waders with long, phenomenally thin legs, and long necks and bills. They use the bills in catching fish, small crabs, and other water animals. The bill may serve as a weapon of self-defense in some cases. Marshes and swamps are the favorite haunts of most of these birds.

Some of the egrets and spoonbills are colorful, graceful birds, valued for their beautiful feathers. The storks include ugly, carrion-eating types as well as the white stork which is probably Europe's most popular bird. All these birds belong to the order Ciconiiformes.

STATELY HERONS

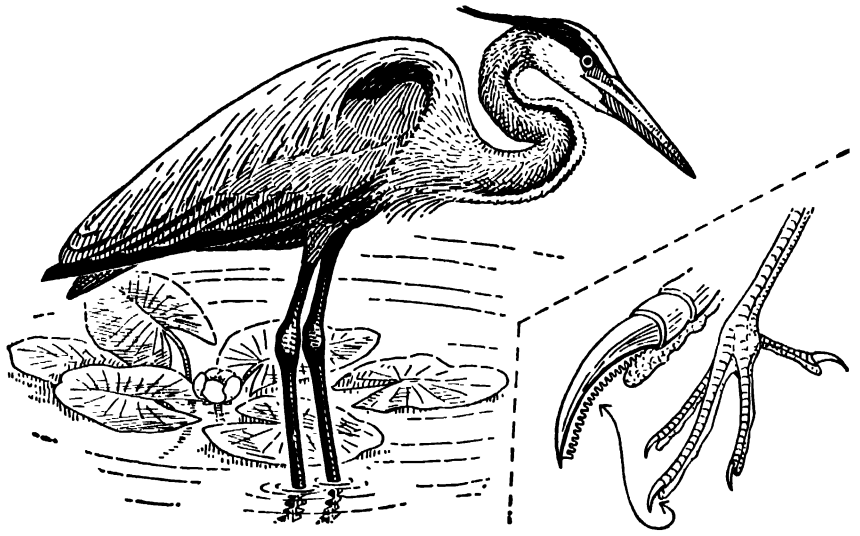
We find herons and bitterns, numbering some sixty species, in all parts of the world. They are wading birds, making up the family Ardeidae, with the long thin legs and toes and long slender neck that are typical of the members of the order. Their chief food is frogs and small fish, which they spear with their pointed bills. Young herons are helpless when born and stay in the nest until they are able to fly.

The Great Blue Heron, *Ardea herodias*, is the largest American heron, and is one of the best known. It stands some four feet high and has a wingspread of about six feet. Its flight is on the slow side but very steady. Country people call this bird a "crane." However, true cranes fly with their necks outstretched, while herons always tuck theirs back on their shoulders. The great blue heron is bluish gray washed with brownish hues below; but at a distance it appears dark.

These birds feed mostly on fish, water snakes, crayfish, and frogs.

Like most other herons, they nest in colonies. Often they place several of their bulky nests in a single tree. The female lays three or four light-blue eggs at one setting, and the adults feed the young by regurgitation.

Gunners frequently molest the heron rookeries, as the nesting colonies are called. That is why these birds prefer to nest on islands, where they are less likely to be disturbed. After the nesting season great blue herons wander over the country and are seen along small streams. They are hardy birds, and a few spend the winter as far north as open shallow water is available.



A FAMOUS WADER

The great blue heron, like others of its kind, is tall, thin, and long-necked, with the lengthy, spindly legs of a wading bird. It puts its long bill to good use in spearing food in shallow water and defending itself. Note the comb-like edge on the middle toe, shown in the detail—it is probably used to groom the plumage.

Though the great blue heron is a timid creature, it defends itself effectively when cornered, using its pointed six-inch bill as a "bayonet."

The European relative of the great blue heron is the Gray Heron, *Ardea cinerea.* In medieval times, falcons were sometimes flown at herons; the expression "doesn't know a hawk from a handsaw" dates from this period. (The falcon, of course, is one kind of hawk, and

"handsaw" is a corruption of "heronshaw," an old English name for the heron.)

Africa is the habitat of the Goliath Heron, *Ardea goliath.* Also known as the Giant Heron, it stands five feet high. This chestnut-headed species, related to the two just mentioned, is, as its name implies, the tallest member of this long-legged family.

The Great White Heron, *Ardea occidentalis,* lives in the Florida Keys, the West Indies, and Yucatan. It is an example of the tendency toward pure white coloring found in many species of herons. This bird appears to have sprung from the same stock as the great blue heron. In some areas we find individuals intermediate in color.

The great white heron has been reduced in numbers by persecution and by the hurricanes that occasionally rip across its exposed habitat. A sanctuary has been established for this stately bird in the Florida Keys.

BEAUTIFUL EGRETS

We bestow the name "egret" upon many of the more graceful and beautiful herons, especially those with pure white plumage. During the breeding season they grow lovely ornamental plumes or aigrettes on their backs.

A generation ago these plumes were in vogue in the millinery trade, and two American species, the Common Egret, *Casmerodius albus,* and the Snowy Egret, *Leucophoyx thula,* were reduced to the verge of extinction by plume hunters who slaughtered these birds in their rookeries and stripped them of their feathers. So reckless were these exploiters that a warden appointed by the Audubon Society to protect the birds was shot to death by poachers. The feather trade has now been halted in the United States. Egrets, terns, and other birds once menaced with extermination are rapidly increasing in number.

Many herons, for reasons we do not know, wander north after the nesting season. In late summer and early fall, American egrets and other southern species often appear as far north as southern Canada. One of the commonest species at these times of the year is the Little Blue Heron, *Florida caerulea,* which is about two feet long and dwells mostly on the Atlantic and Gulf coasts. When young, it is pure white; when older, it is slate blue.

Yet another combination of plumages appears in the Reddish Egret, *Dichromanassa rufescens*. Some adults of this bird are gray and chestnut, others pure white. There are no in-between colors. The reddish egret limits itself to the Gulf coast and a southern range into Latin America; it does not straggle north with other southern herons in the late summer.

THE FEEDING TECHNIQUES OF HERONS

While fishing, herons usually stand motionless with bill poised. As soon as a fish or other victim swims within reach, they spear it with a lightning-like stab of the bill. Some species are more active; the reddish egret, for example, often dashes about in shallow water, jabbing its bill repeatedly into the water after minnows.

More remarkable are the habits of the Madagascar Black Egret, *Melanophoyx*. After locating a school of small fish in shallow water, this egret runs forward a few steps and then extends its broad wings forward over its head until they touch the water. Covered by this canopy, the fish apparently become quiet and the heron takes them easily.

American soldiers stationed in the tropics of Asia during World War II often saw the Cattle Egret, *Bubulcus ibis*. Once, while birding in a vast marsh on Luzon, we watched a group of great water buffaloes, each with two or three of these white egrets on its back, come trudging through the rain and mud. Cattle egrets feed on ticks, picked from the ground around cattle or buffaloes, or perhaps from the backs of the animals themselves.

This heron has recently colonized the New World, including Florida.

The Night Heron, *Nycticorax nycticorax,* is typical of the many herons that prefer to hunt for their food in the evening. The scientific name of the night heron means "night raven"; its popular name is "quawk." Both names refer to the croaks or squawks it utters as it flies to and from its feeding grounds. It feeds mostly on fish.

The night heron is bluish black above and white below, with two long white plumes on its nape. It nests in dense colonies in wooded swamps, and the visitor to these reeking quarters should be as well provided with protective garments as a fireman.

Young night herons often venture out on limbs near their nest. Occasionally they slip and catch themselves by hooking their long necks over a branch. Unable to regain their perch, these young birds literally hang themselves, sometimes remaining suspended long after their death. Even if they fall to the ground without suffering injury, they are no better off—their parents will not come down to feed them.

The Boat-billed Heron, *Cochlearius cochlearius,* of Mexico and countries to the south, has a very flat broad bill. Aside from this distinctive feature, it appears, at least at first glance, quite similar to a night heron.

The Little Green Heron, *Butorides virescens,* with its hoarse sharp call of "scow, scow!" is the most familiar of American herons. The "green" is hardly more than a sheen on its back, the bird being predominantly slaty gray, though somewhat streaked and lighter below.

Unlike most members of their group, green herons rarely nest in colonies. They place their nests ten or fifteen feet high in a tree or vine in some overgrown area near water. These nests are so flimsily constructed that the eggs can sometimes be seen through the bottom!

There are related forms almost throughout the world. We once saw a pair of Philippine green herons disturbed by Igorot children playing along a brook. The herons flew up into a pine tree, uttering scolding notes identical with those of the American bird.

The Bittern, *Botaurus lentiginosus,* which reaches a length of nearly thirty inches, is one of the most distinctive members of the heron tribe. Its feathers are streaked with black, buff, and white—a perfect match for marsh grass. This the bittern apparently knows full well. To enhance the camouflage, it stands motionless, with its bill pointed straight up in the air, whenever an enemy approaches. But this is not its sole defensive device. When wounded or cornered, all herons are dangerous—they strike lightning-like blows with their sharp bills at the eyes of their assailant. Bitterns have deprived more than one person of the sight of an eye.

The bittern builds a grass nest—a flimsy affair—among reeds or cattails and lays four or five buffy eggs. (The eggs of almost all other herons are bluish.) The bittern's "song" is a most peculiar pumping or sucking sound that has given it a variety of local names



McKee Jungle Gardens

THE VIRGINIA DEER WEARS A SPOTTED COAT WHEN YOUNG

The young fawn, too weak to travel about with its mother, is left behind by her when she goes off in search of food. Until she returns, the youngster remains hidden among rocks or tall grass, where its spotted coat helps to camouflage it. Every four hours or so the mother comes back to nurse her baby. When it is about five months old, the Virginia deer loses its spots.

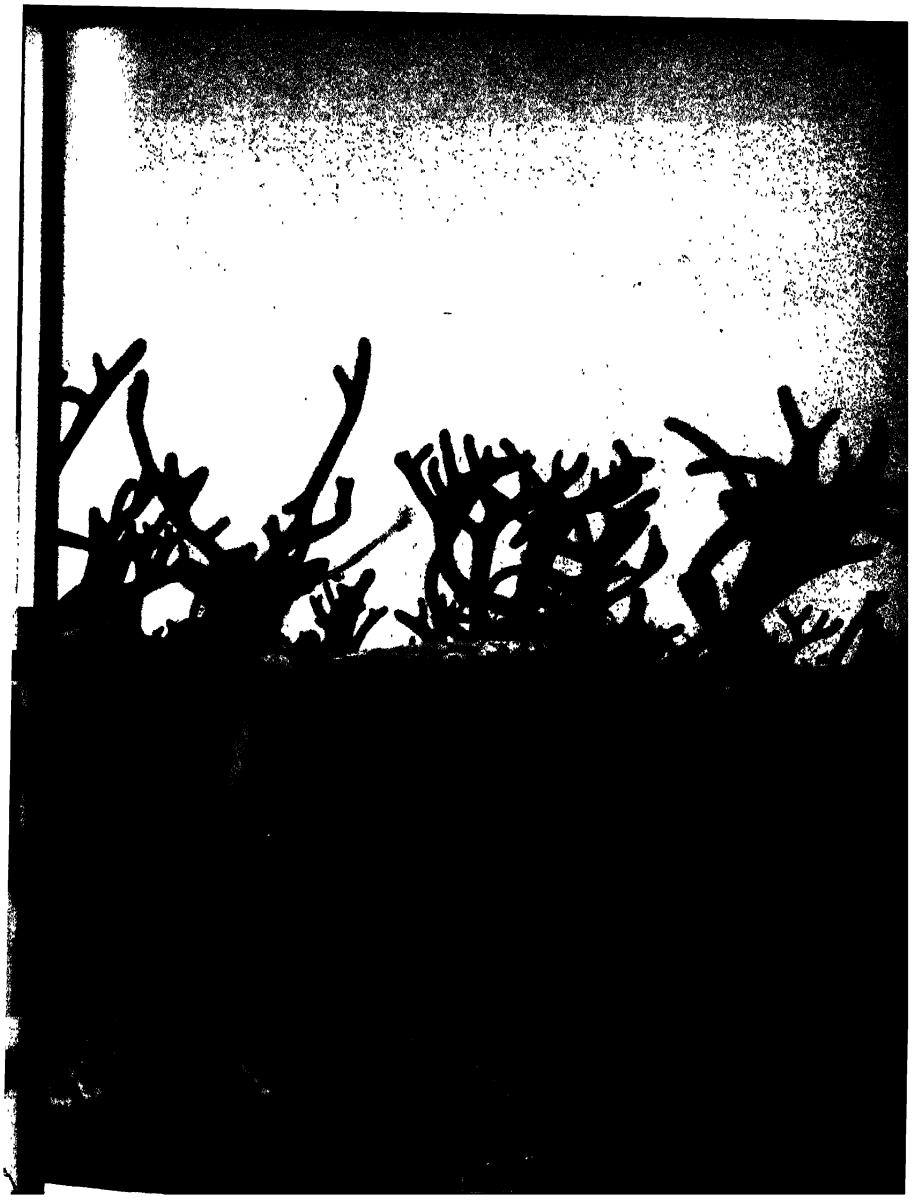


DEER IN COMBAT
A pair of bucks spar, more in play than in earnest. In the mating season their battles are serious, for then they fight for the possession of a doe.

WINTER HERD
Whitetail deer spend the winter in sheltered lowlands, but food is scarce and many starve. Note the three albinos in this herd.

Wisconsin Conservation Dept.





North West Territories Dept. of Mines and Resources

STRANGE SIGHT — A SEA OF REINDEER ANTLERS

Reindeer are unlike other members of the deer family in that both sexes possess antlers. They are the most sociable of deer — migrating herds numbering thousands have been seen in northern Canada. Here their deadliest natural enemy is the Arctic wolf, but they can generally escape him by running, if not taken unawares. Reindeer are at home in both the Old World and the New; in the latter region they are generally known as caribou.



Arabian American Oil Company

ARABIAN ORYXES — THEY DO WITHOUT WATER FOR LONG PERIODS

The handsome antelopes pictured above, known locally as "wudhyhiys," are quite scarce nowadays, and hunting them is prohibited by Saudi Arabian law. They inhabit one of the hottest and driest parts of the world, yet desert life does not seem to inconvenience them. During the long periods of excessive drought they manage to survive without any drinking water.



an Tourist Bureau

South African Railways

LONGEST NECK ON EARTH

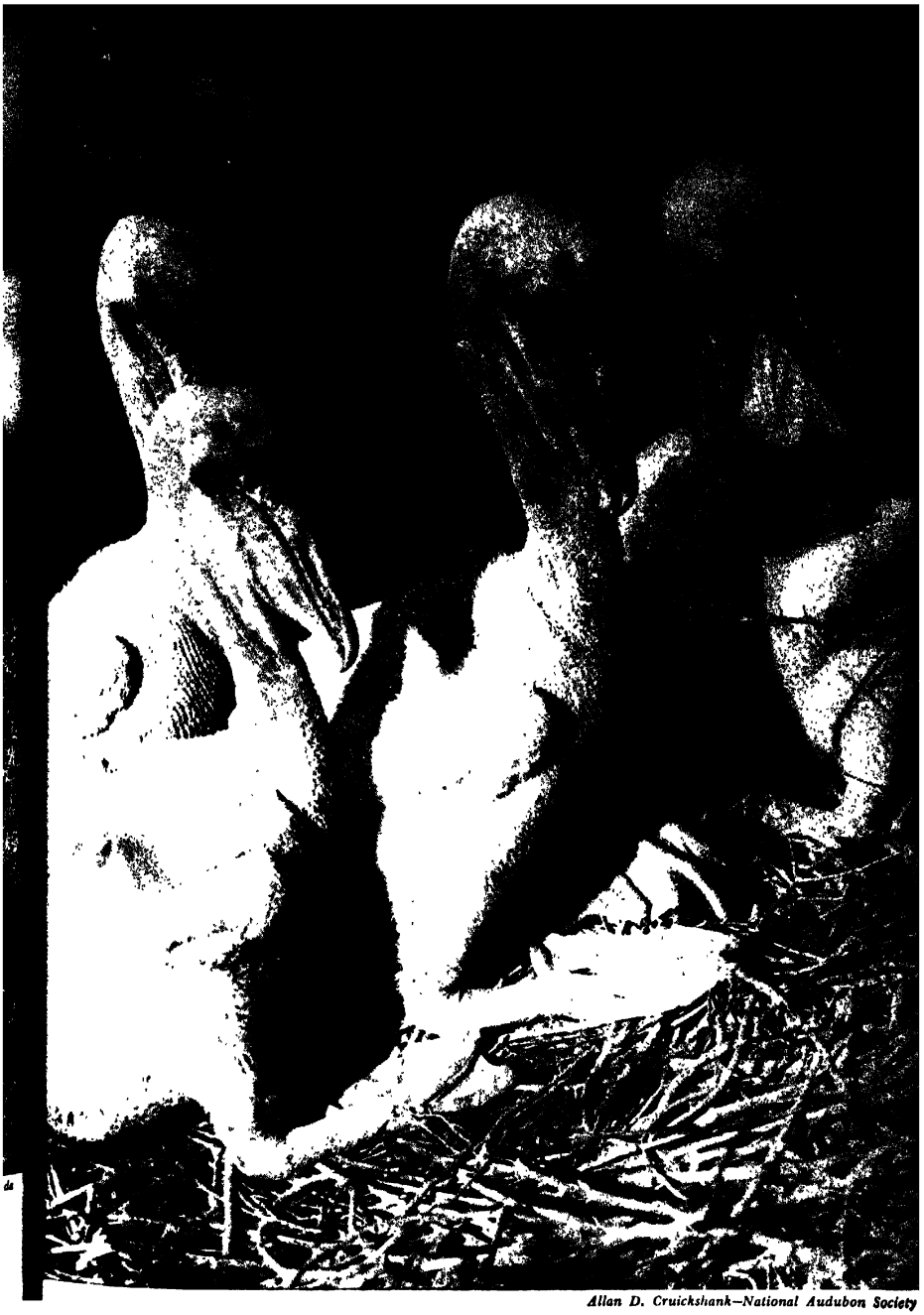
The giraffe, which sometimes grows to a height of nineteen feet, finds its long neck a great convenience in reaching the top branches of trees for the leaves on which it feeds. When it drinks, the situation is different; the animal must spread its forelimbs far apart and bend its knees in order to reach the water. In dry seasons it may go for a month without drinking.



National Film Board of Canada

THE BISON — WILD OX OF NORTH AMERICA

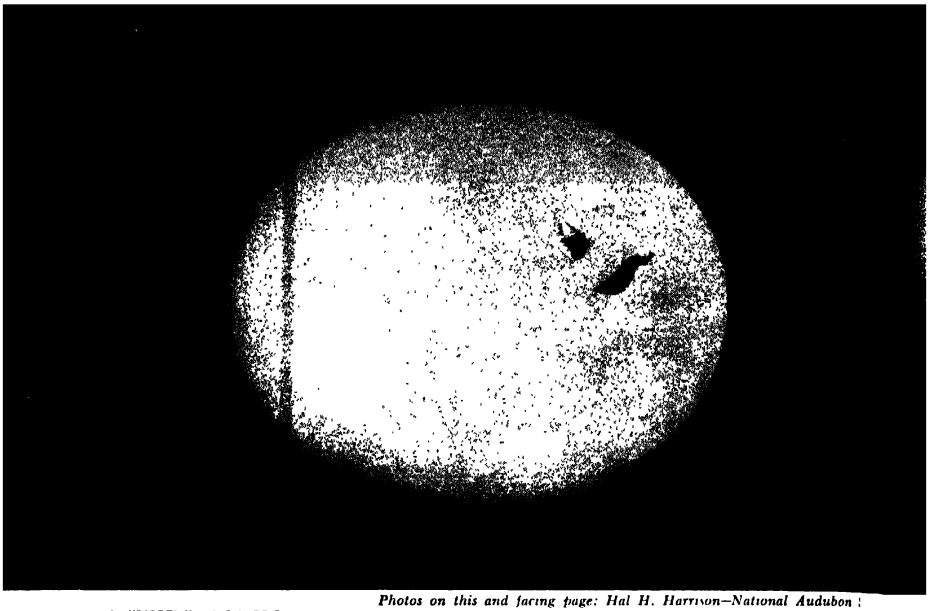
The bison mother bears a single calf, which she nurses and protects tenderly; the young one may remain with her until a new calf is born. Bison, for all their great bulk (they may weigh half a ton or more), are fleet-footed animals, capable of dashing across the plains at a speed of up to forty miles an hour. Once extremely abundant, they now survive mainly in national parks.



Allan D. Cruickshank—National Audubon Society

A FAMILY OF BABY BROWN PELICANS

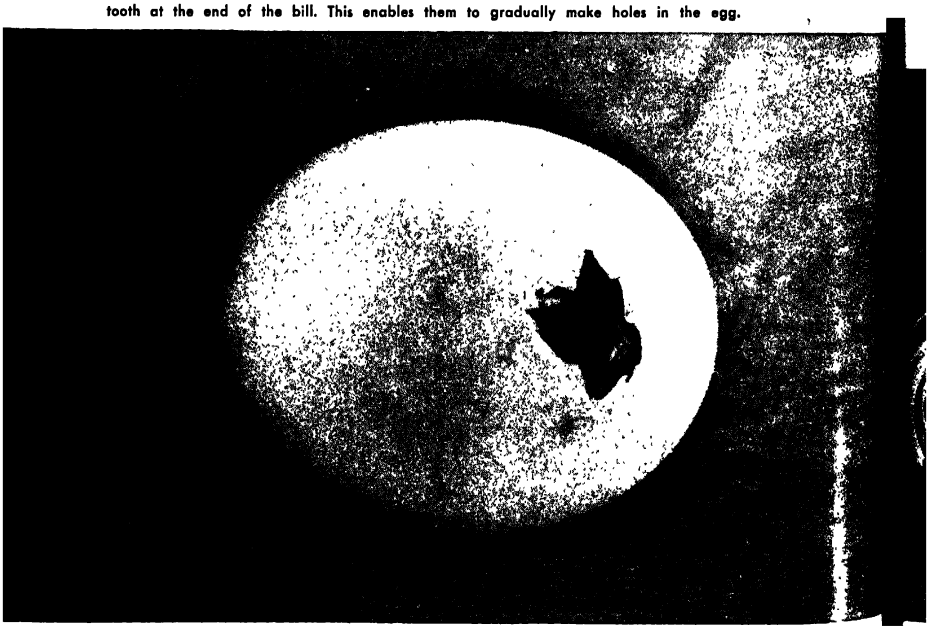
Few baby birds are more ungainly and even ugly in appearance than young pelicans. These youngsters, which are perhaps a week or more old, are already acquiring a covering of down and hence are a little more presentable than they were at hatching time.



Photos on this and facing page: Hal H. Harrison—National Audubon

A "PIPPED" DUCK EGG

This is a duck egg in which the baby duckling is just beginning to peck its way out through the eggshell. Baby birds, at the time of hatching, have a hard little projection called an egg tooth at the end of the bill. This enables them to gradually make holes in the egg.



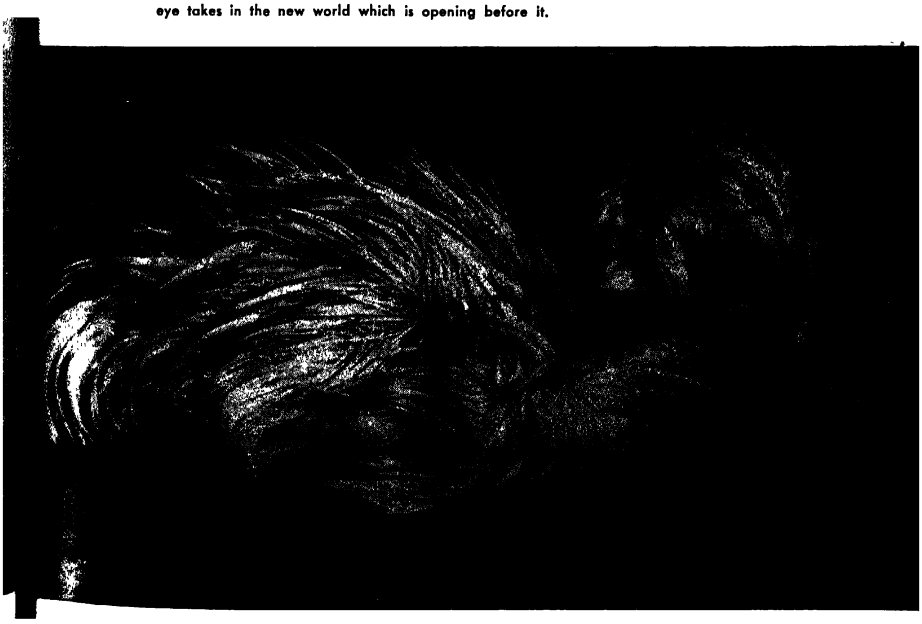
SLOWLY BUT SURELY THE HOLE GROWS

At this stage the young duck has already made a hole of some size in the side of the egg, and the tip of its bill with the egg tooth is visible through it. All young birds hatch and make their way from the egg without direct help from the parents. Often the baby birds begin their peeping cries even before they hatch.



THE DUCKLING EMERGES FROM ITS SHELL

Here the baby duckling has forced its way through the first small hole in the eggshell until finally the shell breaks and the bird is able to emerge. It is still weak but its bright little eye takes in the new world which is opening before it.



THE YOUNG DUCKLING IS WEAK AND WET

The little bird is now completely out of the eggshell but is still very weak and its downy plumage is wet. After it dries and becomes fluffy, the little bird will be ready to follow its mother or even to go in for a swim. At that time the plumage will have become oily.



L. G Kesteloo—Va. Comm. of Game and Inlan

THE LEAST BITTERN IN A DEFENSIVE ATTITUDE

The least bittern, the smallest of our herons, seeks to hide by standing motionless with bill pointed upward at the approach of danger. If it is attacked, it will, when necessary, try to defend itself with lightning-like thrusts of its sharp bill.



L. G. Kesteloo—Va Comm of Game and Inland Fisheries

A LAUGHING GULL AT ITS NEST

This laughing gull has returned to its nest in a marsh to find one of its eggs broken. Like all gulls, it is willing to make known its displeasure by loud scolding. Sometimes the cries of a large flock of these gulls sound like discordant laughter, whence their name. This bird is common along the coast from New York to Florida and westward on the Gulf Coast.



A PAIR OF JACKASS PENGUINS
The jackass penguin, or black footed penguin, nests in large colonies on rocky islands off the coast of southern Africa. This penguin is the one most commonly seen in zoos, where it thrives and may raise young.



A QUARTET OF PENGUINS
Penguins are among the clowns of the bird world. Their erect posture and ludicrous waddling make them prime objects for caricature. Penguins often walk in single file from the ocean to their nests, which may be some distance from the shore.

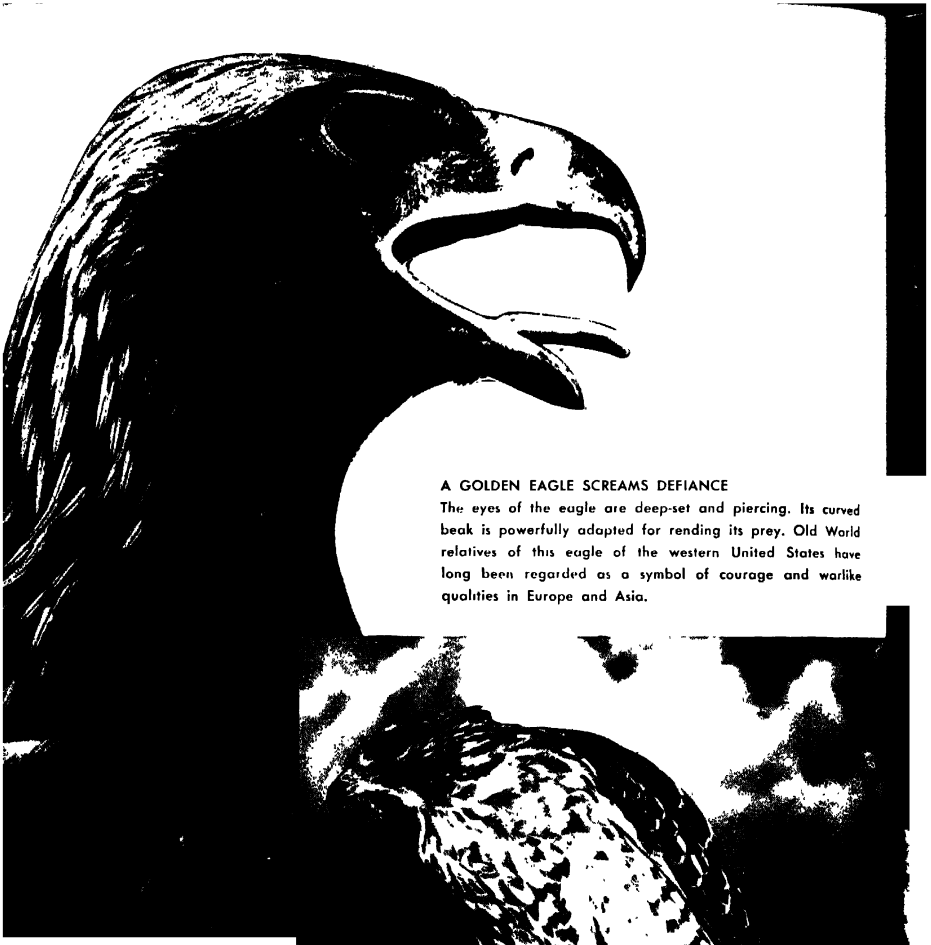


JACKASS PENGUIN "BRAYING"
Here we see how the so-called jackass penguin comes by its name. When in a vociferous mood the bird holds its head upright, opens wide its powerful bill, and utters its raucous, mule-like braying, meanwhile holding its wings out sideways.

Photos on this and facing page: New York Zoological Society



BABY JACKASS PENGUIN
Little penguins are covered with coarse, brownish down and do not at all resemble their distinguished-looking parents. They grow slowly; it takes some weeks for them to reach full size. They do not launch themselves in the ocean until almost fully grown and feathered out.



A GOLDEN EAGLE SCREAMS DEFIANCE
The eyes of the eagle are deep-set and piercing. Its curved beak is powerfully adapted for rending its prey. Old World relatives of this eagle of the western United States have long been regarded as a symbol of courage and warlike qualities in Europe and Asia.

I. G. Kesteloo—
Va. Comm. of Game and Inland Fisheries



BROAD-WINGED HAWK IN IMMATURE PLUMAGE
This graceful little hawk is one of the most useful members of its family, for it lives almost entirely upon small rodents and insects. In the fall it gathers in large flocks and migrates slowly southwards along the high ridges of the Appalachian Mountains. Continuing on, it reaches its winter home, which is located in tropical America.

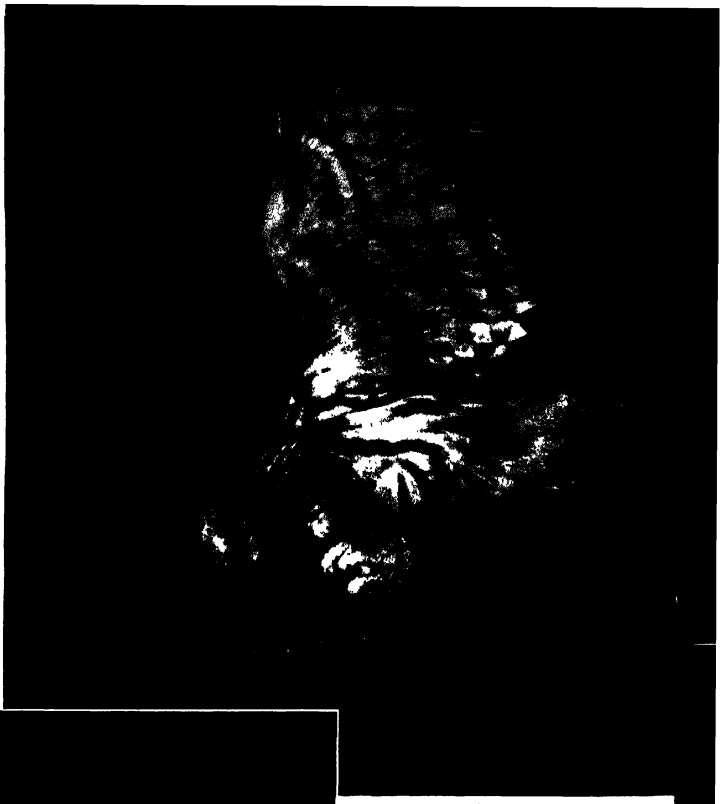
Tenn. Conservation Dept.



L. G. Kesterton—Va. Comm. of Game and Inland Fish

A COOPER'S HAWK ALIGHTING WITH A MOUSE

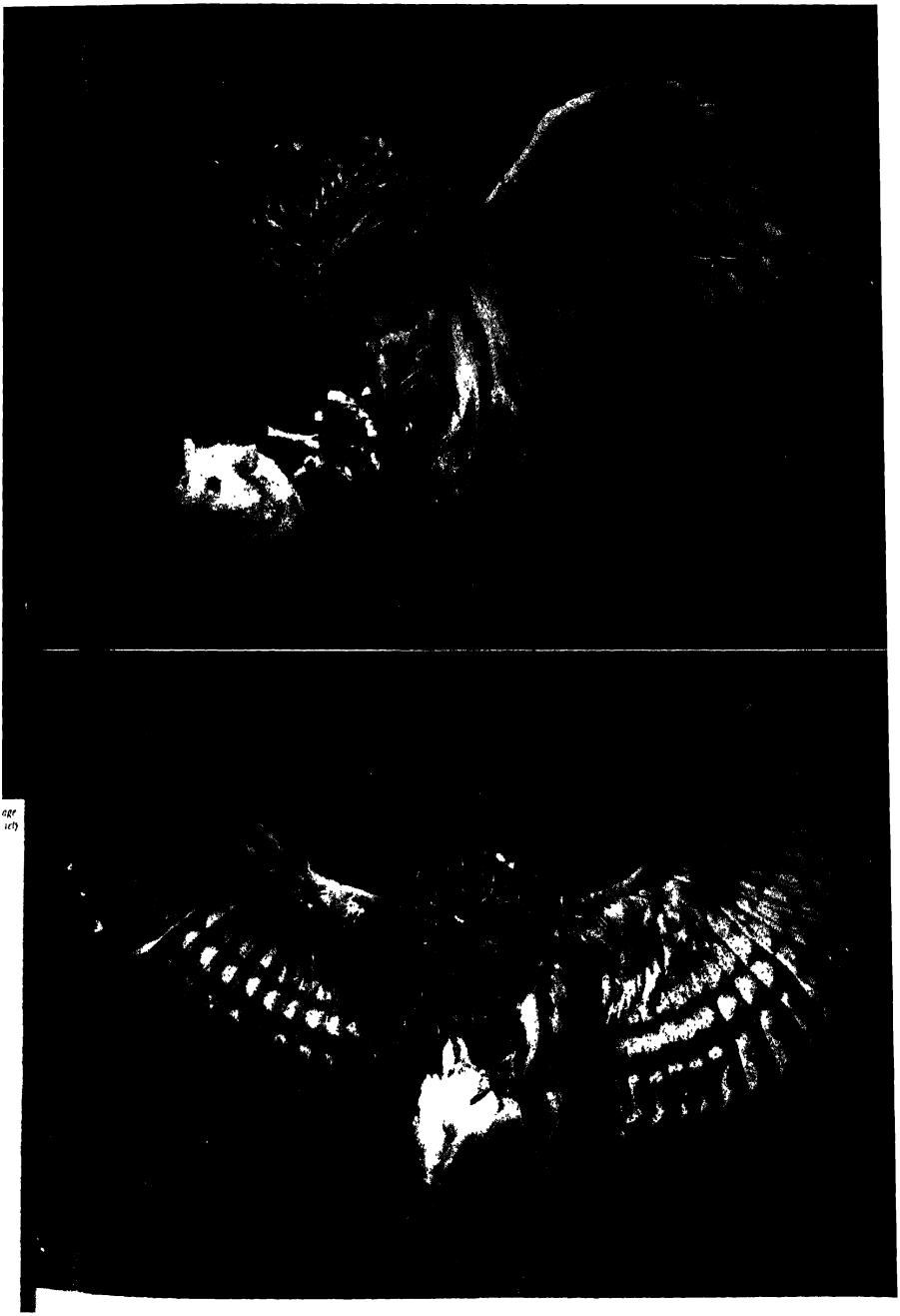
This hawk is intently eyeing the approaching perch, where it must make a one-point landing on its right leg while the other clutches a mouse. The high-speed camera reveals beautifully how the tail is spread wide and the outer wing quills are extended to supply maximum braking.





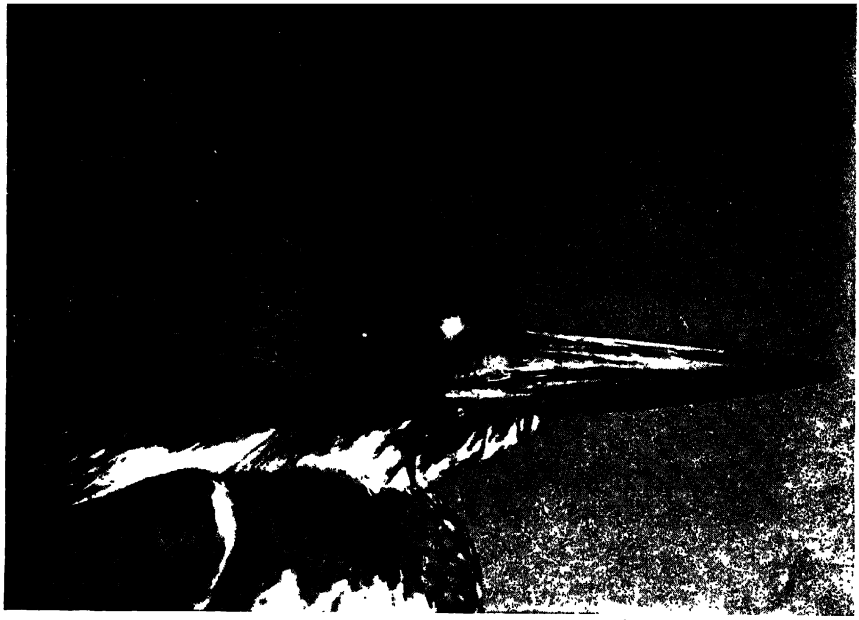
Photos on this and facing page
Robert C. Hermes—National Audubon Society

A SAW-WHET OWL SWOOPS DOWN UPON A WHITE MOUSE
This little owl, like others of its family, has soft, down-fringed feathers that enable it to swoop almost silently upon its prey. The high-speed camera enables us to see, in a way only recently become possible, how the owl intently and gracefully descends upon its unsuspecting victim, a white mouse.



EXIT—ONE MOUSE

In the upper photograph the owl has its claws fully expanded like a pair of grappling hooks. They pierce the vitals of the mouse and kill it almost instantly. Such birds of prey do much to prevent plagues of rodents and other pests.



Hal H. Harrison—Monkmeyer

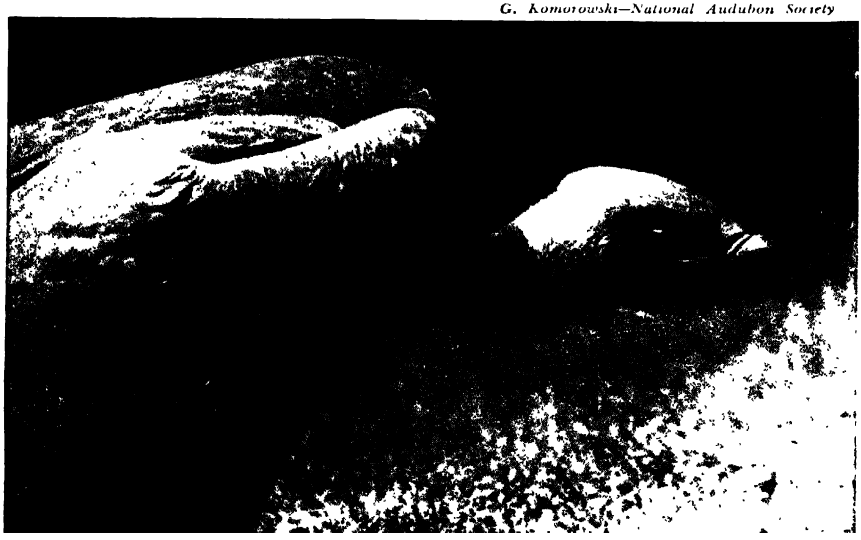
THE BELTED KINGFISHER—A SKILLED FISHERMAN

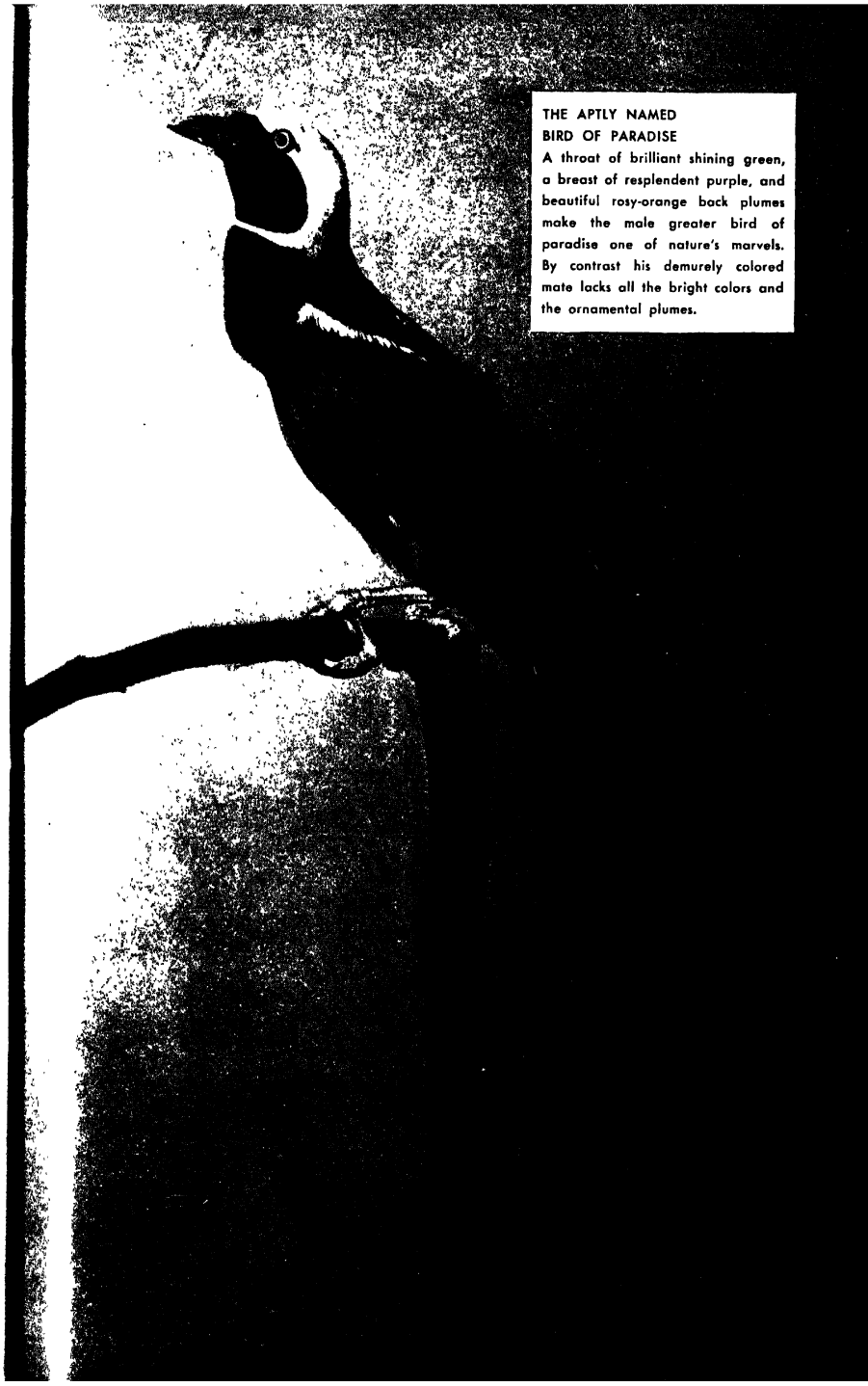
The belted kingfisher hovers above the water until it detects a fish and then plunges head foremost after its victim. Its strong, heavy bill seizes the fish and holds it securely until it can be carried to a convenient perch and swallowed. The kingfisher is a belligerent bird, ready to challenge any others of its kind that attempt to trespass on its favorite fishing grounds.

THE BALEFUL GAZE OF THE GRIFFIN

One does not expect vultures to be handsome birds, and the griffin of southern Europe and northern Africa is no exception. On the bleak, windswept plains of Spain, flocks of six or a dozen griffins sometimes gather to feast at the carcass of a domestic animal. The keen eyes of the griffin enable it to spot food miles away as the bird soars majestically, high in the sky.

G. Komorowski—National Audubon Society





THE APTLY NAMED
BIRD OF PARADISE

A throat of brilliant shining green, a breast of resplendent purple, and beautiful rosy-orange back plumes make the male greater bird of paradise one of nature's marvels. By contrast his demurely colored mate lacks all the bright colors and the ornamental plumes.



HE DISPLAYS
HIS SPLENDORS

Suddenly impelled to give his courtship display, the colorful bird of paradise throws his filmy plumes in a shimmering mass above his back At the same time, with bill widely agape, he utters a series of challenging calls. Then, becoming more sedate, he holds his wings stiffly above his shoulders and hops slowly along the branch.





Bird of Paradise photos: New York Zoological Society

THE CLIMAX OF A WONDERFUL DANCE

Again becoming more active, the bird *(upper picture)* erects his plumes and stands with body held stiffly and wings widely spread. Then, still more frenzied, he inclines his body far forward, displaying the rosy-orange plumes and widespread wings to his mate. The impression is a vivid one, even as viewed here in black and white.



Walker Van Riper—Denver Museum of Natural History

BROAD-TAILED HUMMINGBIRD FLYING BACKWARDS

These striking images are all of the same bird, taken from left to right by successive flashes of an electronic high-speed photographic unit. They show how the hummer, as it leaves the tube from which it has been sucking honey, flies backwards and upwards.



OPEN WIDE, PLEASE

The ostrich is noted for its ability to swallow all sorts of objects, edible and inedible. As this photograph shows, there can be no question about the capacity of its mouth, but the passage of rough objects down its long throat presents more of a problem.

F.S.N.B. Photo



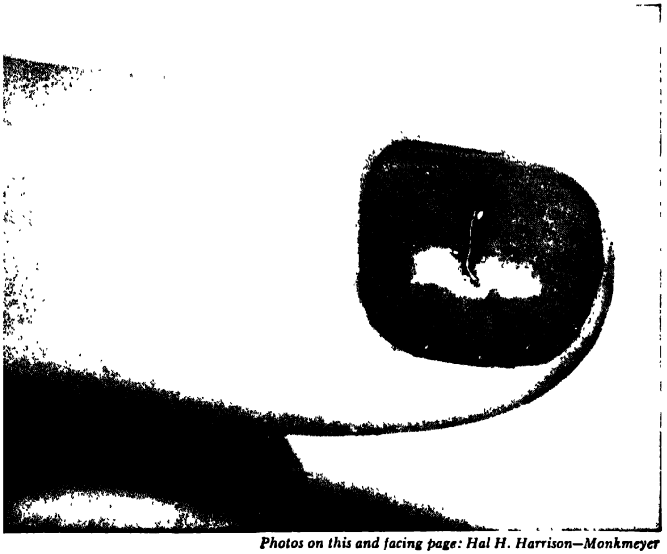
Robert C. Hermes—National Audubon Society

AMPHIBIAN ACROBAT

Tree frogs snare their insect prey with an adhesive tongue, but, as shown in this picture, hands may be necessary to stuff such a large creature as a grasshopper into the mouth. Some of the larger tree frogs eat small tree frogs, pouncing on them from distances of a yard or more. Pads on the toes of these frogs permit them to cling to even the smoothest surfaces.

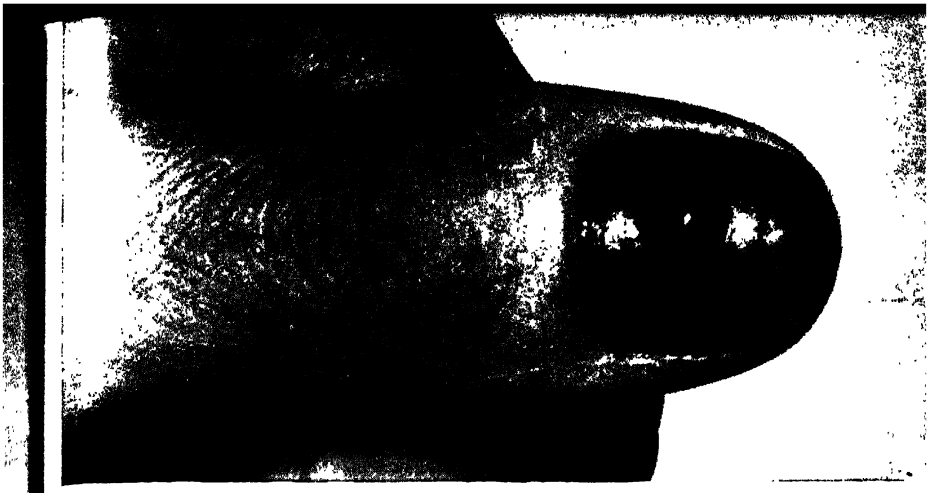


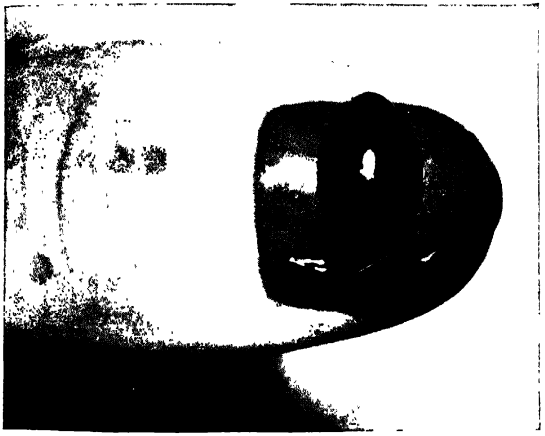
EGGS BY THE THOUSANDS
As many as fifteen thousand eggs may be laid by the American toad in two spiral tubes of jelly. But the tadpoles that hatch from them within the next week or so would be a poor risk for the insurance agent—less than one tadpole in a hundred will live to become an adult.

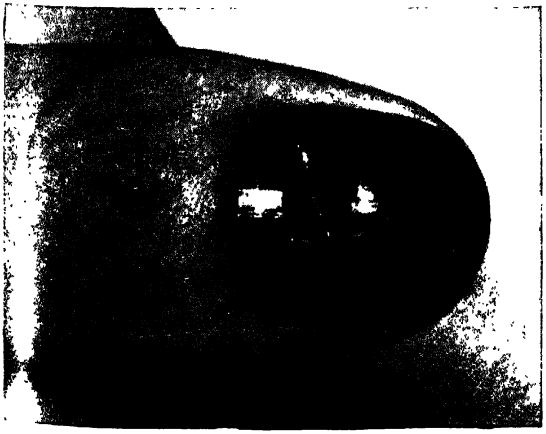


LIFE BEGINS FOR A TOAD
A tadpole several hours after hatching, with gills hidden, and with mouth and eyes developed since hatching.

Photos on this and facing page: Hal H. Harrison—Monkmeyer







THREE STAGES IN THE GROWTH OF AN AMERICAN TOAD TADPOLE

(Top) The tail becomes proportionately shorter with the hind legs about to appear.

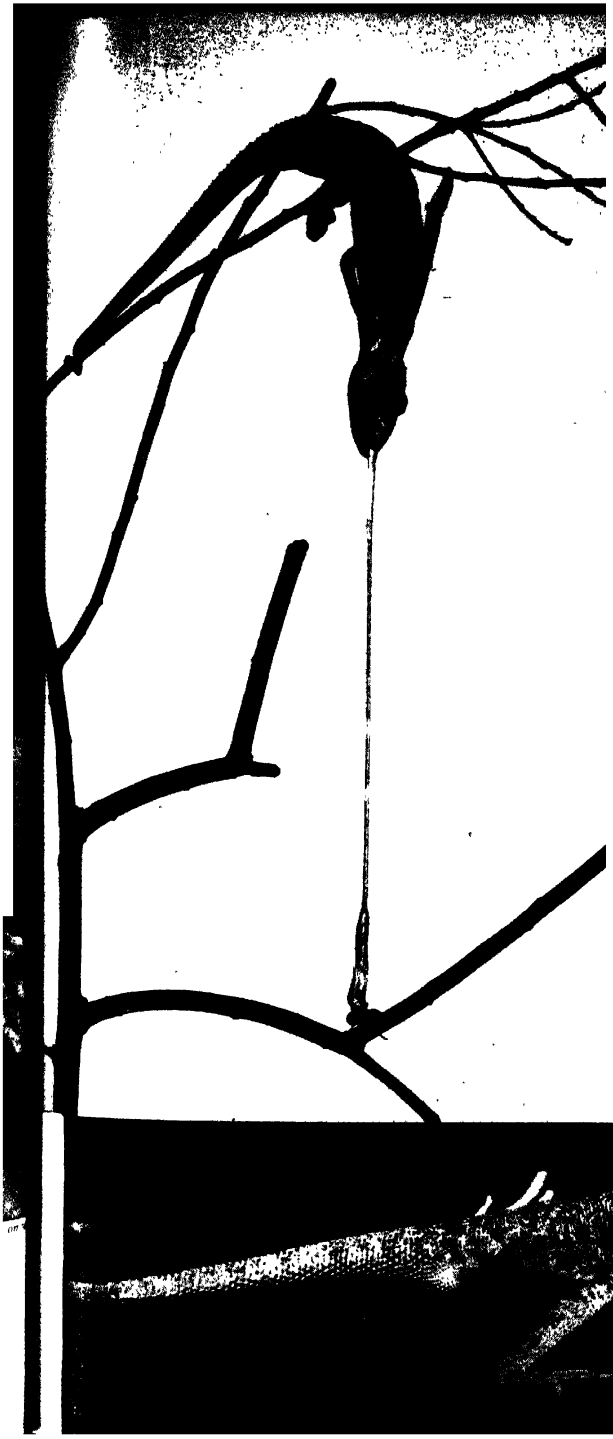
(Center) The hind legs grow larger and forelimbs begin to develop beneath the skin.

(Bottom) All four limbs have developed, lungs have been substituted for gills. Tadpole will soon be ready to leave the water as a toad.



A DWELLER IN THE ARABIAN DESERT

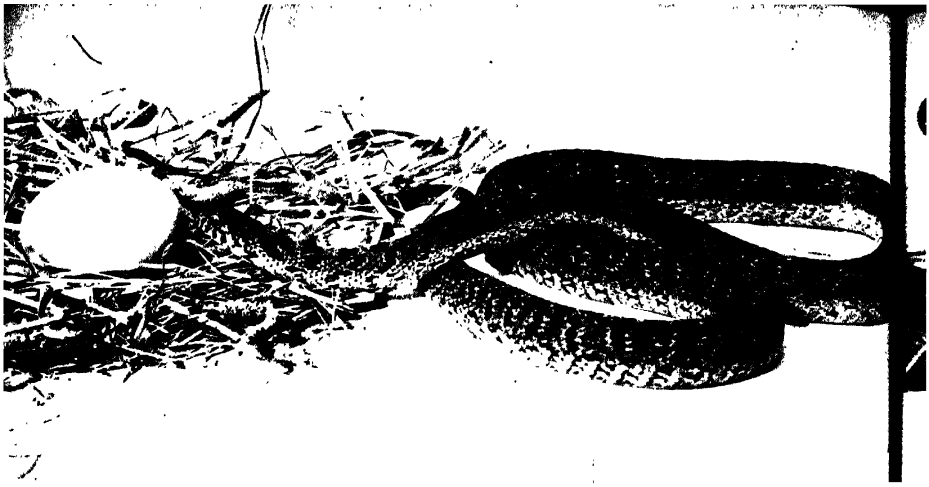
This rock lizard (*Agama*) bears superficial resemblances to some not-so-close relatives inhabiting arid regions in the Americas. The specialized teeth so conspicuously present in the front of the mouth assist the lizard in grasping insect prey.

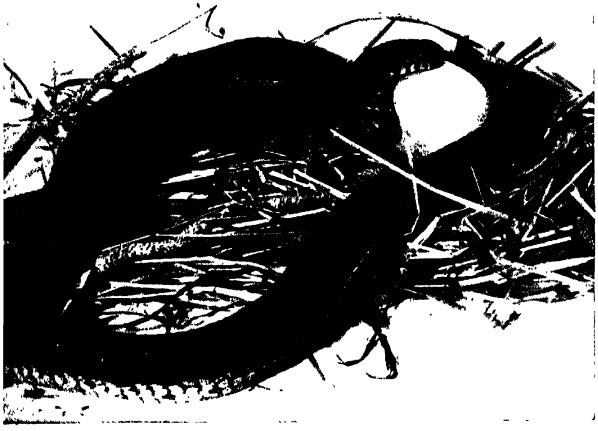


THE CHAMELEON'S SNARE
Only the chameleon among all reptiles has a tongue that can be extended to a distance greater than the length of its body. The sticky mucus on the tip of the tongue snags insects, which are drawn into the mouth to be crushed by the teeth prior to being swallowed.

Pat Kirkpatrick—National Audubon Society

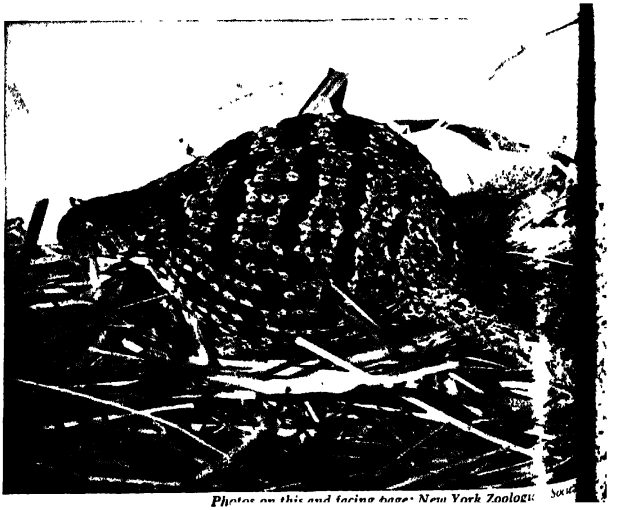
HIDER IN THE SANDS
Confronted by an enemy, this desert lizard will put up a courageous fight. If the danger is too great, however, the animal can quickly sink beneath the sand by vibrating its body.





AFRICAN EGG-EATING SNAKE
The egg is approached, identified as suitable food through the snake's sense of smell. (The tongue picks up odorous particles that are carried to sensory structures in the mouth.)

GETTING STARTED
The task of engulfing the egg gets under way. The two sides of the lower jaw bones are spread apart as the snake advances its lips. The upper jaw is held in place as the lower jaws push forward, with the skin between them drawn up over the egg afterward.



EGG SUCCESSFULLY ENGULFED
With the egg now in its gullet, the snake is ready to crush it by means of hardened toothlike projections from the spine As the muscles contract, these "teeth" crack the shell.

Photos on this and facing page: New York Zoological Society



EGGSHELL EMPTIES
The contents of the egg are spilled out into the gullet for transfer to the stomach as the eggshell collapses under muscular pressure. The snake's neck gradually returns to normal as the walls of the gullet contract.



THE EGGSHELL IS EJECTED
After the egg has been drained of its contents, the crushed shell is ejected. The snake is fre of encumbrances and once more ready to crawl.



DANGEROUS BEAUTY, THE CORAL SNAKE
Gaudily marked with red, yellow, and black rings, the coral snake would be more attractive could it not inflict a deadly bite.

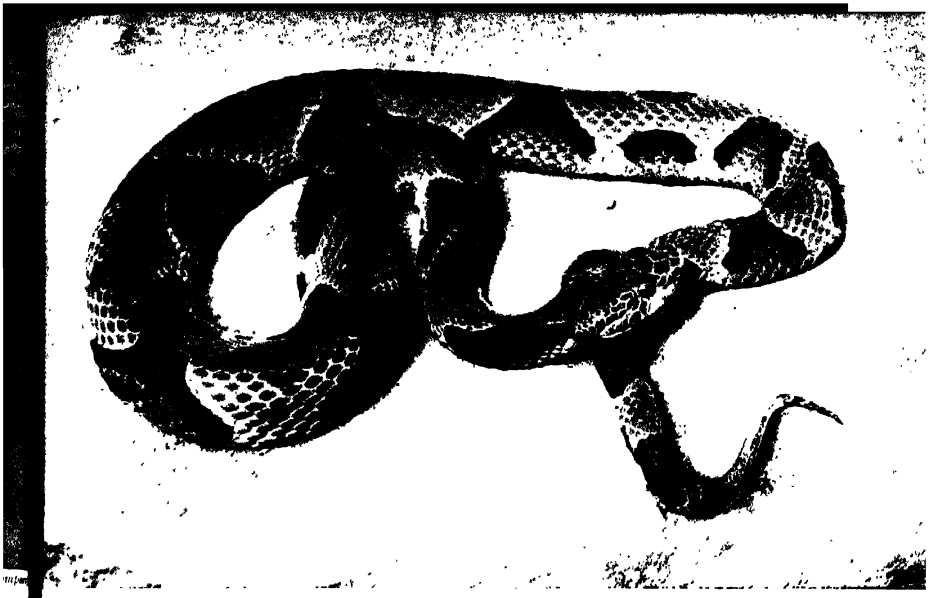
AN ARABIAN RACER
Swift-moving snakes, characteristically with large eyes, are among the few seen abroad by day in the desert.

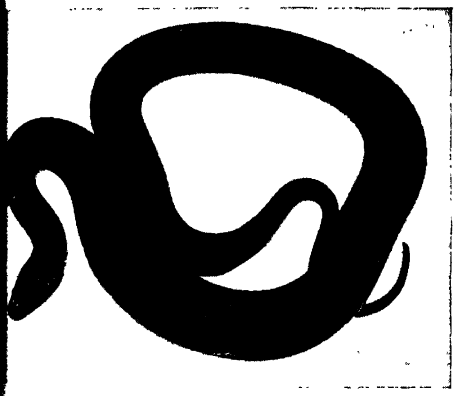


Arabian American Oil Company

Embassy of Pakistan







THE VENOMOUS COPPERHEAD AND TWO SNAKES THAT RESEMBLE IT

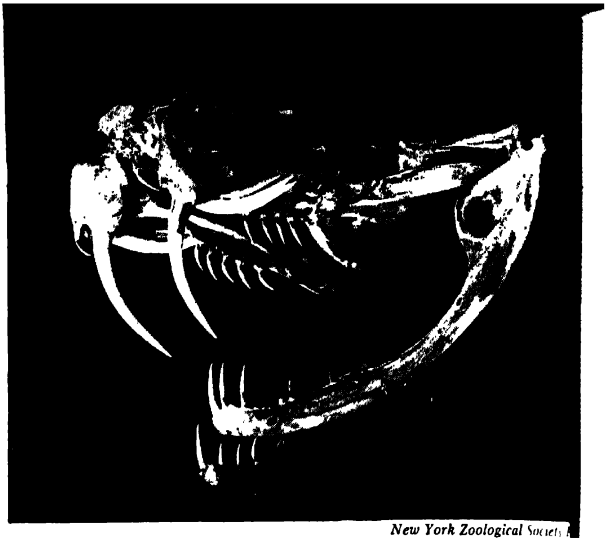
(Top) Copperheads are restricted to the United States east of the Rocky Mountains. Cross-bands are constricted at center.

(Left) The harmless but sometimes aggressive banded water snake of the eastern United States is often mistaken for the dangerous copperhead or water moccasin.

(Bottom) The milk snake, often confused with the copperhead, is found around barns or dairies, where it consumes rodents, but not milk. It is definitely not harmful.

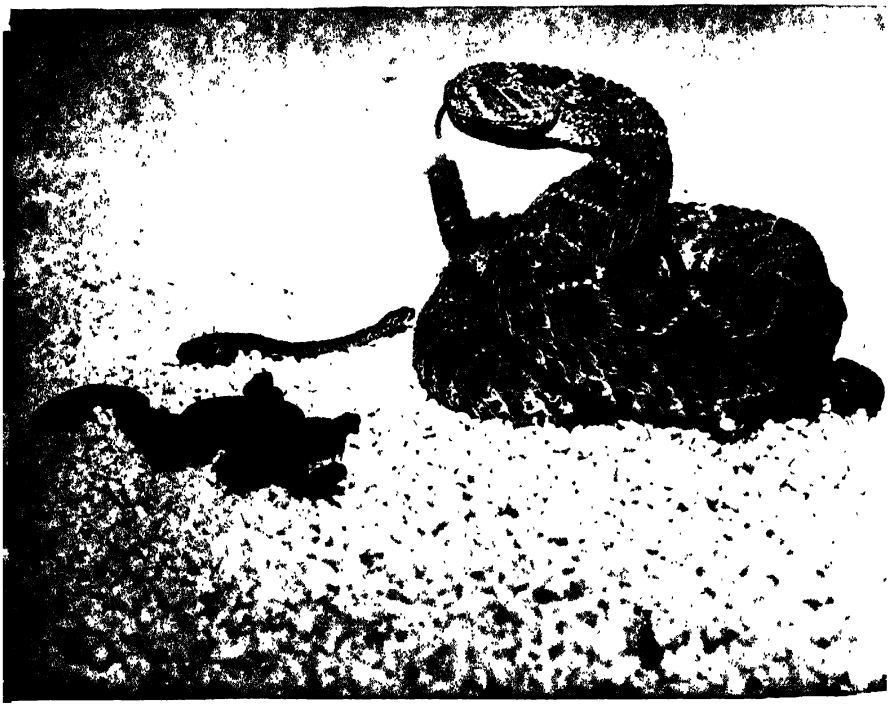
New York Zoological Society Photos





New York Zoological Society

DEADLY HYPODERMIC NEEDLES
The hollow fangs of a pit viper are located at the very front of the skull, where they can be driven into the flesh of the victim by a stabbing action at the time of the strike. Fangs are shed and replaced periodically by others in various stages of growth behind them.



WESTERN DIAMONDBACK RATTLESNAKE AND NEW-BORN YOUNG
More human casualties result from bites inflicted by this rattlesnake than by any other snake in the United States. However, throughout the country, fewer than fifty people die each year from snake bite. Most bites do not prove fatal, even though no treatment is given.

such as "stake-driver." It produces this sound by expelling air from its gullet. During the process it violently contorts its head and neck.

Herons have patches of powder-down feathers on their breasts. Lord Percy concluded from his observations of the European bittern that this powder, like the oil from the gland at the base of the tail, is probably useful in preening the plumage and keeping it clean; the feathers of bitterns and other herons often become stained with slime from eels or other water creatures.

The Least Bittern, *Ixobrychus exilis,* so small that it is scarcely the size of a robin, is similar to the common bittern in habits but more secretive. The least bittern is an awkward flier and, when danger threatens, withdraws stealthily through the cattails by grasping the vertical stems in its feet and proceeding by more or less acrobatic swings from stalk to stalk. This diminutive heron is rather exacting in its requirements for a place to live. It selects only good-sized marshes—usually along the edge of a lake.

The very rare Cory's Least Bittern was once thought to be a distinct species. However, it is merely a deep chestnut-red variety of the ordinary (buff) least bittern. Such reddish phases are called erythrisms to distinguish them from black or white phases, which are respectively known as melanisms and albinisms.

STORKS—POPULAR OLD-WORLD BIRDS

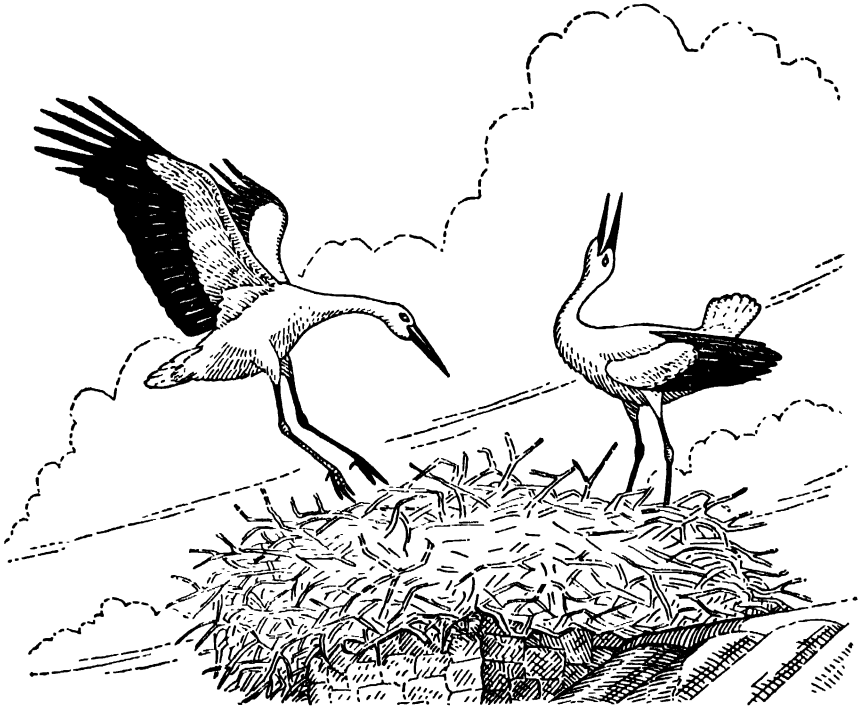
The White Stork, *Ciconia ciconia,* of Eurasia, is the best-known member of the stork family, and doubtless the best-loved bird of the region. It has white plumage with black wing feathers, and its bill and legs are red. In northern Europe this bird builds its huge stick nests on the roofs of buildings or on Dutch windmills. Its long association with man is probably the basis for the story that the stork brings human babies.

The white stork makes lengthy migrations to South Africa. Once back at its familiar nest in the north, it soon announces its presence. It throws its head so far back that its bill touches its tail, and noisily claps its bill. The picture it presents at this time is one of the most grotesque in all bird life.

The white stork lays three or four white eggs. The young are almost naked when hatched and remain in the nest until grown. Even

at the stage where they have reached a height of two feet, the young storks are still unable to fend for themselves!

Like many of the other seventeen species of the family Ciconiidae, the white stork is partial to swampy ground, where it hunts frogs and other small water-dwelling creatures. At times it takes carrion —a food preference even more evident in the Adjutant Storks of Africa and India. The adjutant stork, so called because it walks about



EUROPE'S MOST POPULAR BIRD

The white stork, one of Europe's best-loved birds, is so tall that when the young are two feet high they are still "babies" and need their parents' care. The white body plumage of this stork contrasts effectively with its black bill and red legs. Following its long migratory journey from South Africa, it begins its elaborate courtship antics, posturing with its head back until its bill touches its tail, and clapping its bill loudly. In this picture, the birds are shown on their nest, on a roof.

as stiffly erect as an adjutant-general, is a huge, ugly bird with a tremendous bill. Its head and neck are largely bare of feathers—a trait it has in common with many other scavenging birds. A few ad-

jutants usually mingle with the horde of vultures about dead zebras or other large mammals on the African plains. Adjutants can swallow objects as large as a full-grown cat, and even bones yield to their phenomenal powers of digestion.

The Wood Ibis, *Mycteria americana,* is the only stork found in the United States. (The name "wood ibis" is a misnomer, as the bird is a true stork.) It nests in huge colonies, containing as many as fifteen thousand birds, in cypress swamps in Florida and elsewhere in the southeast. Occasionally it wanders farther north.

The wood ibis is a large white bird (up to four feet in length) with black pinions. Its bare ugly head has earned it a great number of picturesque nicknames, such as "leatherhead," "flathead," "ironhead," "preacher," and "Spanish buzzard." Like all storks, the wood ibis has large wings, which enable it to soar for hours high in the air. It is a silent bird—so are most storks—although the hundreds of young sometimes found in a large rookery can set up a considerable racket when they are hungry.

The Shoebill, or Whale-headed Stork, *Balaeniceps rex,* is a large gray bird about forty inches long. Its huge, thick, hooked bill gives it an appearance quite out of the ordinary. It lives in the extensive swamps of papyrus or other vegetation along the upper Nile and nearby areas in Africa.

This bird feeds mostly on small fish, frogs, and even young alligators. We do not yet know exactly how it uses its huge shoelike bill, but it is reputed to be able to rip up turtles with this formidable beak. We do know that the bird occasionally feeds upon the African lungfish, and further study may even show that it uses its bill to dig these fish out of the mud in which they sometimes bury themselves.

The Hammerhead Stork, *Scopus umbrettus,* makes its home in Africa and Madagascar. A medium-sized, purplish-brown species, it is often placed in a separate family. The hammerhead's nest is a large mass of sticks with a hollow interior. This the bird lines with grass or mud before it lays its eggs, which are white. The entrance to the nest is on one side.

IBISES AND SPOONBILLS

Ibises and spoonbills are medium or large-sized wading birds found throughout the warmer regions of the world, usually near brackish or fresh-water marshes. They swim occasionally and sometimes perch in trees—particularly during the breeding period, when they often assemble in large colonies. As these birds fly, they extend their necks and legs and make frequent short glides. Many species of this family (Threskiornithidae)—notably the Scarlet Ibis—fly in tight aerial formation.

The ibis has a long slender bill, curved like that of the curlew. The spoonbill has a flat wide bill, with a broad-shaped tip. Its notes are unmusical squawks. Males and females of both groups take part in brooding and care of the young. Down covers the newly hatched birds.

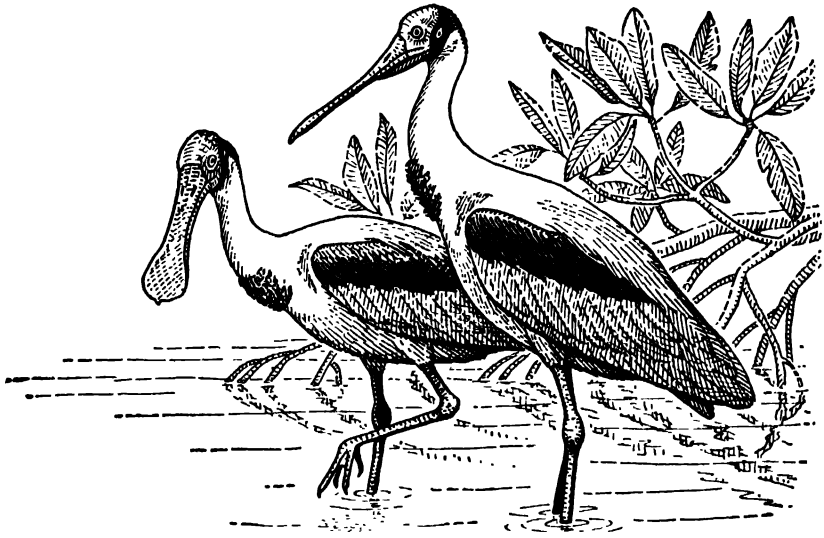
The Sacred Ibis, *Threskiornis aethiopica,* is the most famous of the approximately twenty-six known species of ibises. (The Greek name for the ibis family means "bird of worship.") The sacred ibis, which has white body plumage, lacy black tail plumes, and naked black head and neck, was revered by the ancient Egyptians. They portrayed Thoth, their god of wisdom and learning, as ibis-headed. As the scribe of Osiris (god of the dead), Thoth was charged with recording the deeds of the dead. Mummified corpses of this bird have been found in Egyptian burial crypts.

The White Ibis, *Eudocimus alba,* and the **Scarlet Ibis,** *Eudocimus rubra.* The heron-sized white ibis, native to subtropical and tropical America, is white with greenish-black wing tips. The magnificent scarlet ibis of tropical South America is blazing scarlet with bluish-black wing tips. Both birds are abundant in certain localities, sometimes gathering in flocks of hundreds. Recently, rookeries containing thousands of scarlet ibises and a few white ibises were found deep in the interior of Venezuela. The white ibis nests in the southern part of the United States.

The Glossy Ibis, *Plegadis falcinellus,* is widely distributed in the warmer areas of the Old World. It is rare in the United States, but a large colony has turned up on Lake Okeechobee, Florida. The closely related White-faced Glossy Ibis, *Plegadis guarauna,* is common on the Bear River marshes in Utah and in other suitable localities in

the western part of the United States. Both species are about the size of a chicken and have blackish plumage, with a bronze or greenish sheen. These ibises build untidy nests of grass in tall rushes and lay greenish-blue eggs.

The Roseate Spoonbill, *Ajaia ajaja,* is the only one of the six species of spoonbills that is found in the New World. This beautiful bird has white plumage strongly tinted with raspberry pink, particularly on its shoulders and flanks. Its head and throat are largely naked and yellowish brown in color. It is about thirty inches long, and lives near lakes and rivers.



A BIRD WITH A SPOON-SHAPED BILL

We find an enormous variety of shapes, sizes, and textures in bills; different types are suited for obtaining different kinds of food. The spoonbill is named for its extraordinary bill, which broadens out at the tip so that it is wider than the bird's head. The bill acts as a strainer of small snails, insects, and other favorite items on the spoonbill's menu.

This bird's bill reaches a length of six inches, narrowing in the middle and widening out again at the tip. In fact, the spatulate ("spoon-shaped") tip is broader than the width of its head. Spoonbills feed by "puddling" in the mud and ooze with the paddle-shaped bill. As the bill moves back and forth, small snails and insects are strained out and eaten. The spoonbill's legs, like those of the scarlet ibis, are reddish.

There are still a few colonies of this much persecuted bird on the Gulf coast of Texas. As for the once flourishing colonies of Florida, they are now reduced to scattered remnants, despite the heroic efforts of the National Audubon Society to protect and manage them.

Flamingos—Picturesque Birds

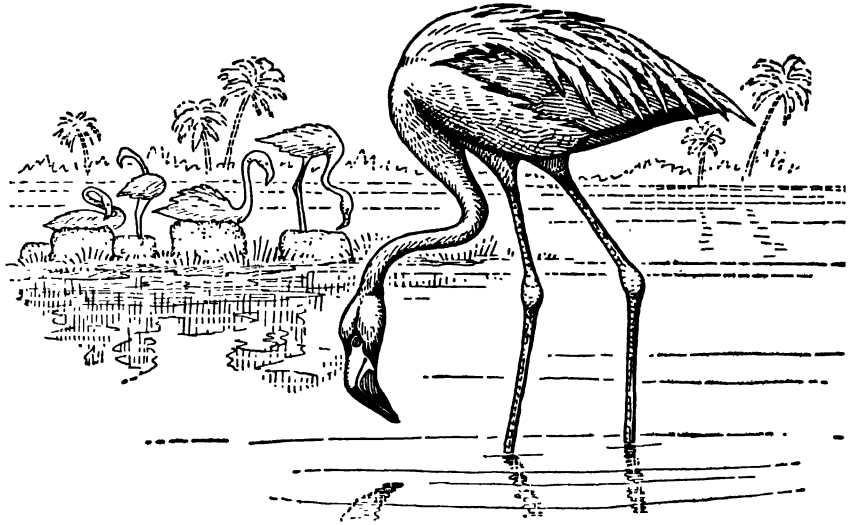
FLAMINGOS usually live in flocks sometimes numbering thousands. They frequent shallow bays and tidal swamps, where they feed in shallow water. Their eating methods are most unconventional. When feeding, the flamingo hangs its head downward and nearly upside down, with its eyes pointed backward between its legs. This position makes it possible for the bent upper half of its bill to scoop into mud and shallow water. The bird separates the edible portion of the food from the inedible with a kind of sputtering noise, like that made by a feeding duck.

When they are getting their food in shallow oceanic waters, flamingos present a curious spectacle as they bend their long necks in rhythm with the wave crests.

In flight, flamingos create an entrancing picture. Their plumage appears to change from white to flashing rose as they wave their long wings. When at rest and lying on the ground or on their pillar-like nests with their legs doubled under their bodies, flamingos remain graceful and bizarre. By bending their necks into snaky coils, they can preen every part of their plumage with ease.

Back in 1832 the famous naturalist Audubon observed flamingos in great numbers in Florida. Today these lovely pink and scarlet birds are still found in large colonies in many parts of the world. The six species of flamingos make up the order Phoenicopteriformes; four of the species dwell in the Western Hemisphere.

In many ways flamingos are rather like ducks and geese. They have a similar comblike sieve arrangement in their bills. They are able to float on water. Moreover, they molt all their wing quills at the same time, as do the ducks. This made the flamingos particularly vulnerable to hunters at molting time in the days before the birds were protected by law.



A BRILLIANTLY COLORED WADING BIRD

The flamingo, a tall thin bird, lives and feeds in shallow water. When feeding, this graceful and beautifully colored creature bends its neck all the way down. Holding its head nearly upside down, it gets its bill in the most effective position for sifting its food from the mud. Shellfish are a favorite dish with the flamingo.

The flamingo lays its single chalky white egg in a nest mound that ranges from several inches to about a foot and a half in height. When perched on these conical posts, the birds have a picturesque appearance. Often they place the nests very close together in shallow bays or tidewater mud flats, and sometimes as many as two thousand nests are crammed into a small area. Both sexes take part in incubation and care of the young.

Emerging in about a month, the young are covered with down. After a few days they leave the nest but remain nearby. The parents feed them by regurgitation.

The Common Flamingo, *Phoenicopterus ruber,* is vermilion, with a black-tipped yellow bill and bright-red legs and feet. Fully grown, it

measures from four to five feet in height. It lives in scattered colonies along the coasts of tropical America and in the Bahamas.

In recent years a large colony of common flamingos has been introduced to a pond located inside the oval of the Hialeah Race Track in Florida. They seem to be breeding quite successfully.

Although the flamingo is chiefly a bird of the tropics, the Andean Flamingo, *Phoenicoparrus,* lives on Lake Titicaca, high in the Andes.

Waterfowl: Swans, Geese, Ducks, and Screamers

Ducks, geese, and swans, collectively called waterfowl, existed in North America in incredible profusion before the coming of the white man. These birds—scientists group them in the order Anseriformes—managed to maintain their numbers fairly well despite the fact that both Indians and white men hunted them extensively as a valued source of food. It was only in relatively recent times that killing for sport and for the market seriously menaced the existence of our waterfowl.

Both the United States and Canada had a common interest in this problem. (The mallard duck, for example, nests chiefly in Canada but spends most of its life in the United States.) Both countries have passed legislation limiting duck-hunting to specified times of the year and outlawing the commercial sale of wild ducks.

The drainage of marshes in many parts of the world has likewise been extremely harmful to waterfowl. To counteract this trend, the United States government has established many sanctuaries and nesting areas for them. This work is largely financed by the proceeds from the sale of duck stamps which every duck hunter must buy.

Aside from the government-created sanctuaries in Florida, Louisiana, North Dakota, Alaska, and other regions, waterfowl are provided for in other ways. Some years ago Oakland, California, set up a temporary home for thousands of wild waterfowl on a lake in the very heart of the city. And at the mouth of the Mississippi River, in what is perhaps the most inviting duck country in the United States, a privately owned tract of fifty thousand acres was set aside for waterfowl. Thanks to such far-sighted measures, the birds are no longer in danger of extermination.

SWANS

Many are the myths and legends, dating back to ancient and medieval times, that testify to the swan's graceful movements and the beauty of its exquisite white plumage. One of the most famous Greek myths is that of Leda and the Swan. To the Greeks the swan was the Bird of Apollo, because according to legend it sang a melody of haunting beauty just before its death. In more recent times the swan legends live on in such works as Wagner's *Lohengrin* and Tchaikovsky's *Swan Lake* ballet.

For centuries swans have adorned the ponds of parks and private estates. The Mute Swan, a semi-domesticated Old World species, is the one most frequently seen in such surroundings.

Mating swans are so devoted that they become strongly attached and remain paired for life. They tend to be rather aggressive towards the other waterfowl, particularly during the nesting season. Swans have been known to retaliate dangerously when irritated by children or dogs.

Few areas in the United States are frequented by truly wild swans. It therefore comes as a surprise to us to learn that there are occasional large flocks of these wild birds, and that they migrate for hundreds of miles. It is also surprising to learn that swans are exceptionally fast fliers and swimmers; most of us see them only when they are gliding with stately grace on a placid lake or pond.

There are about 150 species belonging to the family Anatidae (derived from the Latin *anas*, meaning "duck"). The swans are the largest of these species, and indeed among the largest of all flying birds. Two species of wild swan are native to America, the Whistling Swan and the Trumpeter Swan.

The Whistling Swan, *Cygnus columbianus,* is a little smaller than the trumpeter, and averages fifty-two inches in length. Both have snow-white plumage and it takes an expert to tell them apart. The smaller species nests in the Far North, chiefly north of the Arctic Circle, where it is immune from persecution by all but Eskimos. Thousands of whistling swans winter on Currituck Sound off North Carolina and other coastal waters of southeastern United States. Their voracious feeding on water plants offers serious competition to ducks and geese wintering in the same area.

In the spring many whistling swans migrate overland from Chesapeake Bay to their nesting grounds in the Hudson Bay region. This route takes them near Niagara Falls, and occasionally large numbers of them alight in the river above the cataract. This is sometimes a fatal error for them. Swans must patter over the water upwind for a considerable distance before gaining enough momentum to launch their heavy bodies; once they enter the Niagara rapids they cannot do this, and they are swept to their death.

When migrating, swans fly in formation, uttering loud trumpet-like calls. The whistling swan has a flutelike note which presumably accounts for its name.

Swan courtship is elaborate, and delightful to watch. Swans breed on marshy soil, where they build largish, substantial nests of seaweed, grass, and moss. The female lays from two to seven white eggs, and incubation takes from five to six weeks. Soon after hatching, the young are escorted to the water for their first swimming lesson.

The Trumpeter Swan, *Cygnus buccinator* ("trumpeter"), is the larger of the American species, about the size of the tame swans we see in parks and zoos. It averages some sixty-five inches in length, with a wingspread of from six to eight feet. In fact, this swan is the largest native waterfowl of North America. Its call, as you might expect, is deep, hornlike, and remarkably resonant.

There was a time when the trumpeter swan nested over much of the Great Plains and north to British Columbia and even southern Alaska. As the area where it ranged was taken over by farming, the trumpeter swan decreased in numbers. Overhunting and wanton shooting during the nesting season, plus the losses to marauding wolves, eagles, and coyotes, brought this magnificent bird to the verge

of extinction. Today the trumpeter swans are numbered in the hundreds; still, the species seems to have survived the immediate threat of extermination.

In the United States we find the trumpeter swan chiefly on a few lakes in the Yellowstone Park region, but its major stronghold is now believed to be in British Columbia.

This swan builds a large nest with a base five feet across. Water vegetation is the favored material. Sometimes the swans construct their nests on top of muskrat houses or deserted beaver homes. The female lays from two to ten eggs.

The Mute Swan, *Cygnus olor,* like other Old World swans, is very similar to the American species; it averages about fifty-four inches in length. It is not really mute, as it hisses when angry, and calls its young with a sound that may be described as a feeble bark.

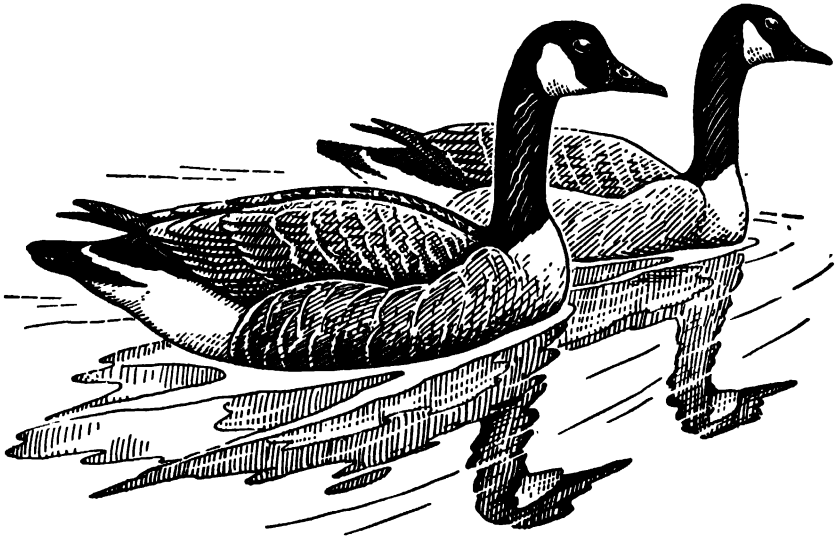
In England this swan has had the status of a royal bird ever since the year 1482, in the reign of Edward IV. At that time, owning a swan became a privilege granted by the king. The owners were also granted the right to use a "swan-mark," a distinctive marking on the upper part of the swan's bill.

The mute swan is commonly seen in parks, and may be recognized by its high arched neck and the knob on its bill. Some captive mute swans made their escape on Long Island in New York and they are now found in considerable numbers on many ponds. In cold weather they are usually able to keep a small area of water from freezing by swimming around; but if this fails they move temporarily to open salt water on the coast.

We have reports of swans living up to fifty and even a hundred years; but these figures are questionable. Thirty to thirty-five years is a more reasonable estimate, based on the life histories of captive swans.

The Australian Black Swan, *Cygnus atratus,* seems almost like a joke of nature, so fixed in our minds is the association of white plumage with swans. This bird was introduced in New Zealand, where it has multiplied so prodigiously that it menaces the food supplies of the native waterfowl. Thus it provides another example of the folly of transplanting birds to foreign countries where their behavior under new conditions may be unpredictable.

The Canada Goose, *Branta canadensis,* is *the* wild goose of America. Ganders weigh as much as twelve pounds, with an average length of thirty-seven inches and a wingspread of about six feet. The sportsman who succeeds in bagging this wariest and most cunning of birds is well rewarded. It is so shy and suspicious that it will not approach man or "duck blinds." The Canada goose is grayish black above and whitish below, with white cheeks and a black head and neck.



THE CANADA GOOSE—A GREAT MIGRATOR

Famous for its long migrations, the Canada goose can fly at a steady pace of fifty-five miles an hour. It usually flies in formation and at considerable elevations. Exceptionally wary in eluding hunters, this goose is one of the most popular of all game birds.

Back in 1840, Audubon wrote a characteristically vivid description of the Canada goose's courtship which still makes good reading. Here is a typically zestful passage: "I can imagine before me one who has just accomplished the defeat of another male after a struggle of half an hour or more. He advances gallantly toward the object of contention, his head scarcely raised an inch from the ground, his bill open to its full stretch, his fleshy tongue elevated, his eyes darting fiery glances, and as he moves he hisses loudly, while the emotion which he experiences causes his quills to shake and his feathers to rustle. Now he is close to her who in his eyes is all loveliness; his

neck bending gracefully in all directions, passes all around her, and occasionally touches her body; and as she congratulates him on his victory, and acknowledges his affection, they move their necks in a hundred curious ways."

The flight of the Canada goose is heavy but powerful. It averages about fifty-five miles per hour. To cut down air resistance, Canada geese usually form a V-shaped flock. The leader of each group is probably an experienced old gander. They migrate over most parts of the United States, announcing their passage, whether by night or day, by wild honking cries. These magnificent migrators sometimes negotiate a nonstop flight of hundreds of miles. It is little wonder that, just as the swallow heralds the spring, the Canada goose has become a symbol of approaching winter.

The Barnacle Goose, *Branta leucopsis,* is an Old World relative of the Canada goose. Nesting in the Arctic on grounds that were not discovered until 1921, the barnacle goose occasionally visits the Atlantic coast of the United States.

In medieval times the fact that no eggs or goslings of this species were ever found gave rise to the legend that it emerged, fully developed, from barnacles. According to Gerard's *Herbal,* which appeared in 1597, "there are to be found in the north parts of Scotland, and in the islands adjacent, called Orchades, certaine trees whereon do grow certaine shells of a white colour tending to russett, wherein are contained little living things, which shells in time of maturitie do open and out of them do grow those little living creatures, which falling in the water do become fowles, which we call Barnakles."

DUCKS

We are apt to think of ducks as having a very distinctive appearance, with their flat bills, webbed feet, waddling gait, and familiar quack. In practice it is difficult for us to distinguish between the duck and the closely related goose. As a rule, ducks are much smaller than geese. Ducks spend most of their time in the water; while geese, on the contrary, do a great deal of grazing on green vegetation on land. Ducks quack, whereas geese utter loud honking cries. But even these distinctions between ducks and geese do not hold good on a worldwide basis; we find many tropical waterfowl that are more or less

crecca, of which the American Green-winged Teal is a race, is handsomely spotted and barred below and has a cinnamon-colored head with a green eye-stripe.

The Blue-winged Teal, *Anas discolor,* has large bluish areas on its wings. It is sometimes confused with the Shoveler, *Anas clypeata,* which has similar wing patches but may be distinguished by its broad shovel-like bill. The shoveler uses this spatulate bill to sift out tiny snails and insects from muddy water.

PERCHING DUCKS

The Wood Duck, *Aix sponsa* ("bride"), is the most beautiful of our waterfowl. It is the only native representative in the United States of the perching ducks, so called because they perch in trees. By way of adaptation to this kind of life, they have longer legs than do most ducks.

The drake's intricate pattern and color scheme defy brief description but include many shades of salmon, buff, and blue. A flowing crest, striped with white, adds to its impressive appearance. Its feathers are much in demand for fly-fishing.

This species nests in a hollow tree or a large birdhouse. The female lays up to fifteen eggs. The nest may be as high as sixty feet above the ground, but the fluffy ducklings flutter down without injury and set off after their mother toward the nearest body of water.

The wood duck, once very rare, has benefited by special protection. In parts of the Midwest it is now invading city parks and streets, where it nests in any available hollow tree and sometimes leads its young down a city gutter in search of wider waters.

The Chinese Mandarin, *Aix galericulata,* is, if anything, an even more ornamental bird than its relative the wood duck. Its feathers, like those of the wood duck, are used a great deal for tying trout flies.

The Muscovy Duck, *Cairina moschata,* has been domesticated and is raised for its meat. It is often seen in tropical countries, where it stands the heat better than other domestic ducks. Its name is misleading, as it is a native of tropical America, not Russia! A large perching duck, bluish black with white wing patches, it hisses like a goose and is so big that it resembles a goose when in flight.

DIVING DUCKS

These birds are also known as bay or sea ducks. Unlike the dabbling ducks, which feed in shallow water, the diving ducks, living in deep water, often dive for their food. The diving ducks include many beautiful and interesting waterfowl.

The Lesser and Greater Scaups, *Aythya affinis* and *Aythya marila,* are the commonest American species of diving ducks. Both have black heads, white under parts, and finely penciled or wavy whitish and black upper parts. The lesser scaup is slightly the smaller of the two and has its head glossed with purple instead of green. However, we usually find it difficult to tell them apart. In winter they frequent lakes and coastal bays, diving to considerable depths for small clams. Scaups are very rapid fliers and are popular as game birds.

The Canvasback, *Aythya valisineria,* is regarded more highly than any other duck by the sportsman. The name of the species is derived from *Vallisneria,* the scientific name of wild celery. This is a favorite food of the canvasback and one which imparts to its flesh the flavor prized by epicures.

In the old days vast numbers of canvasbacks and other waterfowl were shot for the market in Chesapeake Bay and nearby waters; today, even with the sale of game prohibited, the hunting pressure is so great that it is hard to give our waterfowl enough protection to maintain their numbers.

The body of the drake canvasback is largely white, with a black breast and chestnut-colored head and neck. The female duck's head and neck are brown and her body grayish.

The Old Squaw, *Clangula hyemalis,* owes its name to the fact that to the Indians a flock of these noisy birds sounded like a group of squaws gossiping! Other popular names are "old wife," "old granny," and "old Molly." The old squaw holds the record for diving among ducks. On the Great Lakes this species is often caught in gill nets at depths of 150 feet or more. Its flesh is rather too gamy for most palates.

The Common or American Merganser, *Mergus merganser,* is sometimes a nuisance around trout streams. The Hooded Merganser, *Lophodytes cucullatus,* vies with the wood duck in beauty. It feeds

mostly on crawfish and small insects and needs all the protection we can give it. Like the wood duck, it nests in hollow trees, and sometimes the two species attempt to nest in the same cavity! Although birds lost their teeth some sixty million years ago or more, fish-eating mergansers have evolved toothlike serrations along the edge of their bills to aid in holding the fish. The name "merganser" originally meant "sea-gander."

Eider Ducks, *Somateria* ("downy body"), are represented by four species. Almost all waterfowl line their nests with down plucked from their breasts, but the eiders, nesting as they do on such cold, wind-swept coasts as those of Labrador and Norway, need added protection for their eggs. This they provide with a plentiful supply of down, two or three inches thick.

Whenever the duck leaves her nest, she carefully covers her eggs with down, both to keep them warm and to conceal them from enemies. The down is an excellent insulator, and the Norwegians, among others, use it to make clothing for wear in extremely low temperatures. In northern Europe, eiderdown has been collected for centuries—in carefully regulated amounts so that the birds do not decrease. In the United States, eider ducks were slaughtered recklessly, and the Indians consumed great quantities of the eider's eggs.

Male eiders are handsome black and white birds. The pattern varies from one species to another, but all of them have feathers of a peculiar shade of green on the head or neck. The females are plain brown birds—they must be inconspicuous when brooding, to escape foxes and other marauders. All the eiders live in northern regions; in midwinter a few get as far south as the eastern tip of Long Island in New York. Excursions farther south are rare indeed.

The Labrador Duck, *Camptorhynchus*, while never very common, used to occur in fair numbers near Long Island in winter. Before anyone realized what was happening, this handsome bird became totally extinct, for reasons largely unknown to us.

The Harlequin Duck, *Histrionicus*, has a queer feather pattern of white marks and circles suggesting the makeup of a clown. To this resemblance the duck owes its curious name. At present it is the rarest of the diving ducks on the northern Atlantic coast of North America. It is much commoner in the Northwest, where it nests

along turbulent mountain brooks in the Rockies and winters among the coastal islands of Alaska. Harlequin ducks prefer rocky coasts pounded incessantly by heavy surf.

SPINE-TAILED DUCKS

The Ruddy Duck, *Oxyura jamaicensis* ("spine-tail"), is an outstanding member of the group of spine-tailed ducks, which contains some of the queerest members of the whole family. It makes its home in North America and the West Indies. The drake is a chunky little bird, bright chestnut above and white below. The pointed tail feathers are usually directed straight upwards in jaunty style. The wings of the ruddy duck are small, and when it takes to the air the results are rather ludicrous. Hunters call it by such names as "bumblebee coot." The ruddy duck is such an unsuspicious and interesting bird that many would prefer to see it altogether eliminated from the list of game birds.

The female ruddy is careless about domestic affairs and often lays a few eggs in the nests of other ducks before she gets around to making a nest of her own. The related Black-headed Duck, *Heteronetta,* of South America, goes a step further and always lays its eggs in the nests of other waterfowl, leaving them to hatch the eggs and care for the young, insofar as they require care. This is the only species of waterfowl with parasitic nesting habits.

SCREAMERS—AUDIBLE TWO MILES AWAY

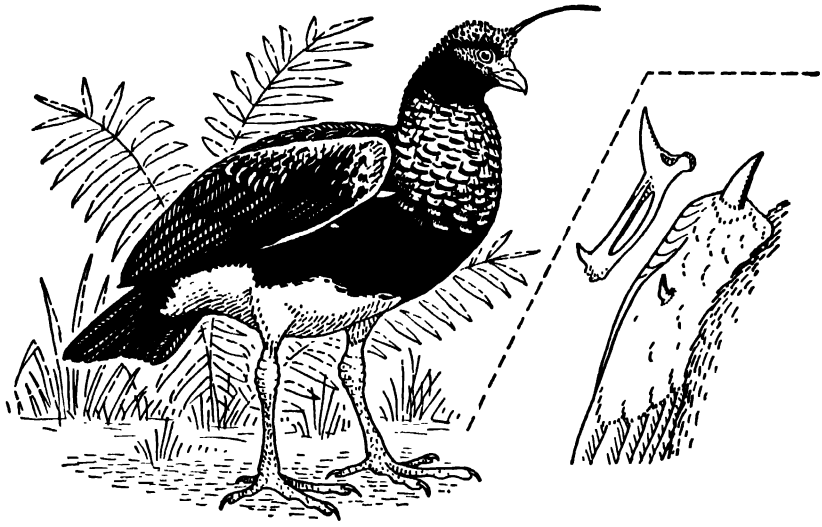
When you see the name "screamer," you know what to expect! However, the three species of screamers, all natives of tropical South America and all related to ducks and geese, have more than one remarkable characteristic. As might be expected from their name, the most obvious is the raucous cry which can be heard at a distance as great as two miles. The bird delivers this scream from a standing position as it pitches its head vigorously backward. (Sometimes groups assemble to scream together!)

Another noteworthy characteristic of the screamer is its scalpel-like spurs. These spring from the bend of each wing, and are sufficiently long and sharp to be dangerous to a man handling the bird. Thirdly, the screamer's ribs show no trace of the little projections (known as

the "uncinate process") which strengthen the thorax structure in all other living birds.

Another interesting feature is that the screamer has a fatty cushion of air-retaining cells between its skin and body. This gives it great buoyancy in the water.

The Horned Screamer, *Anhima cornuta,* lives in the flooded forests along swampy streams. Brown, gray, and white, this goose-sized bird has a slender "unicorn"-like spine springing from its forehead between the eyes. The longest of the wing spurs (there are two on each wing) is more than an inch in length.



A RAUCOUS BIRD

The screamer is named for its raucous cries, which can be heard two miles away. Sometimes a group of screamers perform in concert. This bird may be dangerous to handle because of its sharp wing spurs (*shown in detail*), which are firmly anchored on the wing bones. The screamer has a fatty air-cushion which helps keep it afloat in water.

Screamers are at home on the ground, where they gather in large flocks, or in the water, where they both wade and swim. However, their toes are not webbed. At times they soar gracefully, high in the air. Their chief food is vegetable matter obtained in marshes. All screamers are grouped in the family Anhimidae.

The male and female are similar in appearance. So far as we know, these birds mate for life. Their favorite place for a nest is the

shallow water of quiet ponds or streams. They build the nest by piling up a mass of sticks and rushes, some two feet high. Here the female lays four to six buffy white eggs. Buff and gray down covers the young when hatched.

Eagles, Hawks and Their Relatives

Most of us are inclined to be sentimental about birds. We think of them as gladsome songsters with endearing traits, or lovely creatures resplendent in all the colors of the spectrum. The birds in *this* chapter are not like that at all. The hawks and their cousins remind us of Tennyson's phrase—"Nature red in tooth and claw."

The eagles and hawks are renowned as birds of prey; some feed on small mammals, others on reptiles, on fish, on insects, on their fellow birds.

The eagle will haggle in mid-air with the osprey over the mangled remains of a fish. The fierce goshawk will pursue a breathless, panicky hen right into her very coop. The serpent eagle will spy a snake slithering through the grass, and dive down to its distant prey. To these aggressive birds, size means little. More than one kind of hawk will tackle animals as large as itself.

The day-feeding birds of prey—hawks, falcons, eagles, and related birds—are all included in this important group. They are well equipped for their way of life, with their hooked beaks, curved claws or talons, powerful wings, and wonderfully keen eyes. From the pygmy falcons, scarcely bigger than sparrows, to the condors and eagles, there is a tremendous range in size. Among many birds of prey, such as the owl and the hawk, the female is larger than the male. Why? We do not know.

It is something of a letdown for us to learn that this group includes some of nature's most effective garbage collectors—the vultures. Avid as these birds are for carrion, they see much of the seamy side of life—and death. Some of them are hideous, and their eating tastes are even more repulsive. Yet we must admit that they render us a valuable service on their scavenger hunts.

Of all the Falconiformes, as the birds of this order are called, the eagle probably means most to us. Since ancient times it has been a symbol of warlike, courageous qualities. It rode the standards of Caesar's legions; it was the emblem of the Bonapartes; it straddles the Great Seal of the United States. For centuries, hunters have used trained eagles or falcons in the chase. During the Middle Ages some species were reserved just for the nobility, and an elaborate ritual surrounded their capture, training, and flight. Even today, certain Asiatic tribes still use Golden Eagles for hunting, while in the United States and England there has been a revival of interest in falconry.

Falcons, buzzards, harriers, kites, as well as the true hawks themselves, are all popularly called "hawks." Most of these birds build a large nest of sticks high in a tree or on the ledge of a cliff. Their eggs are few in number, rarely more than five. The young are covered with down and develop slowly. Even after learning to fly, they are fed by their parents until they master the difficult art of capturing prey.

Young hawks reared by man gradually learn to hunt by instinct and without training, but this is a slow process. In the wild, they need their parents to supply them with food until they can catch enough for themselves.

Some species of hawks mate for life and use the same nest year after year. If one of a pair is killed, the other one usually secures a new mate promptly; in fact, this process may be repeated a number of times in a single season.

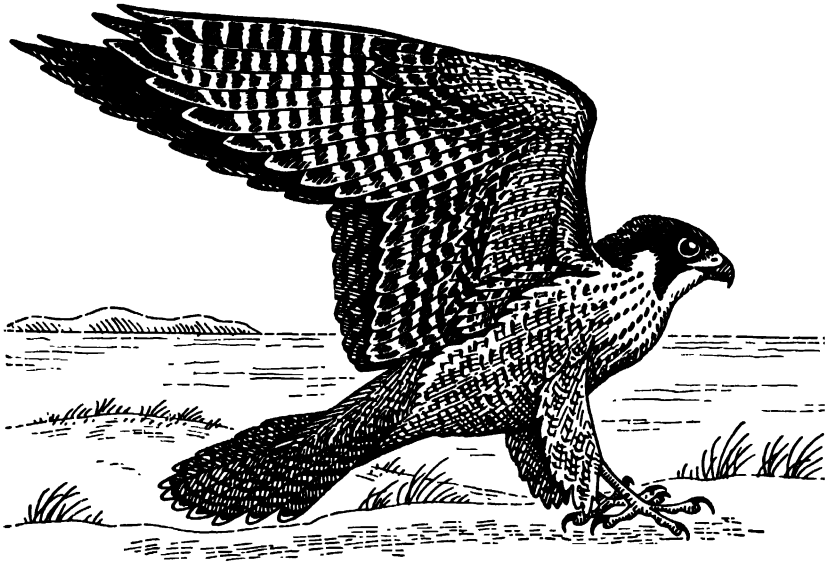
Although hawks occasionally catch birds or poultry, very few make a habit of it. Nevertheless, most farmers, hunters, and gamekeepers shoot all hawks on sight. This is a sad error on their part. Actually, hawks feed mostly on rats, mice, and other destructive rodents, and thus do a considerable service to mankind. Except under unusual circumstances, the number of game birds taken by hawks is too few to have any appreciable effect on any given species. Nowadays we know that the survival of most game birds is determined not so much

by birds of prey as by the amount of food and cover available in wintertime.

Quite aside from the economic question, the wild beauty of a soaring eagle or the arrow-like plunge of a falcon is something to be treasured by all of us who love the outdoors. Bird-lovers and naturalists should constantly strive to teach the public that birds of prey deserve and need a reasonable measure of protection.

FALCONS—SUPERB BIRDS OF PREY

The Peregrine Falcon, *Falco peregrinus,* is considered by some the fastest of all flying birds. Observers have credited it with a diving speed of 180 miles an hour! The peregrine falcon is the best known



THE PEREGRINE FALCON—MAGNIFICENT FLIER

The most famous of the falcons, the peregrine falcon vies with the swifts for the title of the world's fastest flying bird. It easily outflies its prey or else hurtles down upon it from high in the sky with amazing speed. Medieval falconers gave this bird long and careful training; their name for it was the "noble falcon."

of the true falcons, which number about sixty species and make up the family Falconidae. They are found in all parts of the world.

Like many of its relatives, the peregrine has a gray back and wings, and under parts that are whitish, barred with brownish black on the

breast and sides. The female is up to eighteen inches in length, with a wingspread of about three feet.

In the New World, the peregrine breeds from the Arctic to Louisiana; though absent from most of tropical America, except as a migrant, it reappears in southern South America and the Falkland Islands. It makes its home throughout the Old World, nesting in such dissimilar regions as Siberia, Borneo, and Australia. The peregrine is commonly called the "Duck Hawk" in the United States, because it often preys on flying ducks.

Within its range the peregrine does not settle in large numbers or just anywhere. It lives, as a rule, only on cliffs in the vicinity of water. As with most true falcons, no nest is built. The male scoops out a shallow "scrape" on a ledge to which, by all sorts of spectacular aerial maneuvers, he induces his mate to come to lay her eggs.

We may still find a few peregrines nesting on suitable cliffs even in the vicinity of such centers of population as New York City. In the winter these birds often move into the cities to prey upon pigeons. Indeed, a few peregrines have attempted to nest on ledges of high city buildings—usually without success.

The dashing qualities of the falcons are most intensely developed in the peregrine. Its powerful, compact body and long pointed wings hurtle it through the air with tremendous velocity as it plunges after its prey. Its feet are unusually large and sturdy, so that in some localities it is called the "Bigfooted Hawk." All these qualities make the peregrine the species favored above all others by falconers. That is why it was known in the Middle Ages as the "noble falcon"—one of nature's aristocrats.

The peregrine has suffered much from persecution and egg-collecting. The revival of falconry also threatens it, for many inexperienced enthusiasts secure young falcons, only to let them die of neglect or mishandling.

The Gyrfalcon, *Falco rusticolus,* is the largest of the typical falcons. An arctic species, it usually moves southward only slightly in winter, although it is occasionally observed in the latitude of Long Island in New York. As with so many arctic species, white plumage is not uncommon. Some gyrs are almost white, others heavily mottled with gray. It used to be believed that there are two species of gyrfalcons, but we now know that gray and white birds may be born in the same brood.

The gyrfalcon is but little inferior to the peregrine in spirit, and was also a favorite with medieval falconers. Their knack of keeping this arctic species in good health in temperate regions has not been duplicated by our modern falconers.

In one of the most fascinating chapters of his *Travels,* Marco Polo tells us how Kublai Khan kept ten thousand hunting birds—gyrfalcons, peregrines, sakers, and eagles—each with its own falconer. Lying on a couch in a pavilion placed on the backs of four elephants, the great Khan would give orders to have his favorite gyrfalcons pursue cranes and other birds in the air. Seizing their victims in mid-air, the gyrfalcons would finally subdue them after a long, violent struggle. Their royal master took keen delight in the spectacle, relishing it for hours on end.

The Prairie Falcon, *Falco mexicanus,* ranges over arid regions of western North America wherever cliffs or mesas provide lofty, desolate nesting sites. A sandy-colored species, it blends admirably with the landscape. The prairie falcon's flight is somewhat more buoyant though less forceful than the peregrine's. The two birds are about the same size. The prairie falcon feeds on ground squirrels, but it has been known to kill jackrabbits twice its size.

The Pigeon Hawk or Merlin, *Falco columbarius,* is generally smaller than the bird it is named for. The male pigeon hawk is about ten inches long; typical pigeons are often five inches or more longer. You might think, therefore, that the pigeon hawk got its name from a tendency to prey on pigeons. The fact is, though, that the pigeon hawk received its name from a slight resemblance to the pigeon in flight. The pigeon hawk is courageous enough to tackle the larger bird occasionally; but as a rule it feeds on smaller birds, seizing even such rapid fliers as swallows in full flight. By preying on the destructive English sparrow, this hawk renders a distinct service to man.

The pigeon hawk's body is slaty blue above and somewhat streaked below. It is a highly migratory species, being common in the West Indies in the winter though its breeding range lies almost entirely north of the United States. It is related to the merlin of Europe, after which it is also named.

The Sparrow Hawk or American Kestrel, *Falco sparverius,* a handsomely colored chestnut falcon with black facial markings, is found

throughout the Western Hemisphere. It preys chiefly on large insects, small birds, and mice. When hunting, it hovers intently above its victim, and then pounces upon it.

The sparrow hawk is not too fastidious when it comes to nesting. A tree cavity or birdhouse will serve—even a crevice in a building.

The sparrow hawk's small size (eleven inches in length) is a boon to it in a way; it has allowed this bird to escape some of the enmity which the farmer reserves for the larger hawks. Today the sparrow hawk is the commonest bird of prey in the United States, and is well known for its familiar cry of "killy! killy!"

In the Old World we find a close relative of the sparrow hawk in the Kestrel, *Falco tinnunculus*. Conservationists, solicitous for the welfare of the American species, would like to see the name "American Kestrel" come into wider use. (The number of birds it catches, sparrows or otherwise, is trifling.) The name "sparrow hawk" gives this bird a bad reputation that is really undeserved.

THE PYGMY FALCONS

Among tropical members of the falcon family, the pygmy falcons are worth our notice. The Philippine species is white below, bluish black above. This bird has a flair for dashing after flying insects from a favored lookout in some dead tree. At such times you might easily mistake it for a flycatcher, which also has the knack of seizing its prey on the wing. However, a captive pygmy falcon soon proves itself to be, for its size, every bit as powerful and vicious as an eagle.

CARACARAS

Most falcons, as you have seen, are fierce, powerful birds. The caracaras, dwellers in the American tropics, seem lackadaisical by comparison. The northernmost member of this group is the Audubon Caracara, *Polyborus cheriway*. Though only of moderate size, this striking black and white species is sometimes called the Mexican Eagle. We find it in southern Florida, Texas, and southward. The Audubon caracara, like the other caracaras, feeds mostly on carrion. However, it does not disdain live prey, especially snakes, turtles, and frogs. It has long powerful legs and is almost as nimble as a chicken when it comes to running about on the Mexican highways in quest

of refuse. It is chicken-like also in its habit of using its legs and feet to turn over or scratch among fallen branches and other litter in search of food.

HAWKS, EAGLES, AND THEIR RELATIVES

In this group we find some of the most rapacious birds of prey, as well as some of the most avid garbage and carrion collectors. The family, known as the Accipitridae, is quite a large one, containing some two hundred species—most of the hawks, kites, eagles, and the Old World vultures. As we have intimated, these birds are, for the most part, neither ingratiating in their ways nor attractive in appearance. They are mainly dour, fierce creatures, lovers of solitude. But they are wonderful flying birds and they are magnificently adapted for the kind of life they lead. In some cases—the eagles are notable in this respect—they have a wild majesty which compels our awe if not our affection.

KITES—GRACEFUL SCAVENGERS

Light and graceful flying birds, the kites, so called, are really slender-bodied hawks. The Old World kites are scavengers, first and foremost. That is the way Shakespeare, for one, pictured them: ". . . this slave's offal will batten all the region kites." In India, kites still swarm in the villages in search of garbage. As you might guess from their feeding habits, their claws are almost as weak as vultures'.

The Red Kite, *Milvus milvus*, formerly very common in England, is now rare. It is remarkable for its long forked tail and its beautifully easy flight, which gives the impression of a very large swallow in the air.

This is even truer of the American Swallow-tailed Kite, *Elanoides forficatus*, once found over much of eastern North America. Today it is limited to little more than Florida, and to tropical America. Floating effortlessly through the air, it occasionally swoops down for a small snake or a dragonfly. The swallow-tailed kite builds its nest in the very top of tall slender Florida pines and lays three or four whitish eggs attractively blotched with chocolate brown.

The Everglade Kite, *Rostrhamus sociabilis*, is a bluish-gray bird. In the United States it makes its home only in Florida. Even there we

find very few of these birds, limited mostly to a few marshes along the shores of Lake Okeechobee. They also dwell in South America and the West Indies. The everglade kite has a small slender hook on its bill. It uses this hook to pry the meat out of large snails, which it catches by diving into shallow water and paralyzes with a thrust of its beak.

Another beautiful species, urgently in need of our protection, is the White-tailed Kite, *Elanus leucurus*. Aside from a few areas in California, it has disappeared from the United States. The Mississippi Kite, *Ictinia mississippiensis*, a leaden-hued bird, is still fairly common in the South Central states; a related form lives in South America. Like all the American kites, it hunts living prey—chiefly insects and reptiles.

THE BAT HAWK—NIGHTTIME PROWLER

The Bat Hawk, *Machaerhamphus uncinus*, is apparently the only member of the large family Accipitridae that is active at nighttime. Rather few naturalists have had a chance to observe the bat hawk, as it makes its home in Africa and in southeastern Asia. A recent writer has described how bat hawks make their way at dusk to the entrance of great caves in Borneo to pounce on bats as they emerge from the caves to begin their nightly wanderings.

ACCIPITERS—FIERCE BIRDS OF PREY

The hawks that live chiefly upon birds are grouped in the genus *Accipiter*, which has no less than forty-four species. They have short, rounded wings and long tails. Their bodies are admirably suited for gliding through thickets and branches—an assurance of highly effective action in the pursuit of small birds. In the air, they secure their victims by short bursts of speed rather than by open, continued flight.

The Goshawk ("gosling" hawk), *Accipiter gentilis*, is the largest of the Accipiters. It averages some twenty-two inches in length, with a wing spread of almost four feet. We find this rangy bird throughout the Northern Hemisphere, nesting in forests of cone-bearing trees as far south as Pennsylvania in the East and northern Mexico in the

West. The grownups are handsome birds, slaty gray above, barred below, with black facial markings and blazing red eyes. The young are streaked with brown above and below. As in all members of this genus, the male is smaller than the female, sometimes weighing only two-thirds as much as his mate.

As we have seen, the Accipiters prey chiefly on birds. The goshawk, however, is somewhat of an exception to the rule. True, it seizes some grouse and other large birds; but, generally speaking, it feeds a lot more on mammals—mainly rabbits and squirrels—than do other members of its genus.

You need very little information about the goshawk before you conclude that its appetite and aggressiveness are quite out of the ordinary; so much so that it will chase chickens right into their coops! Rabbits, noted for their fleet-footed knack of outrunning their enemies, sometimes try to escape from the goshawk's clutches by dashing into a brier patch. But the insatiable pursuer plunges right in after them, hobbling along on foot in a furious attempt to drive out its prey. The goshawk, by the way, is the only American hawk that regularly launches a fierce attack upon any person venturing near its nest. Even the mighty eagles almost never display such spleen at the sight of intruders, innocent or otherwise.

The goshawk's hunting methods do not have the flashy qualities of the true falcons'. Yet it is an even more effective game-getter, and is sometimes trained to hunt rabbits and grouse. As you might suspect, once the goshawk has grasped its prey, it will rarely loose its grim hold—no matter how violently its victim struggles or how furiously it fights back.

The Cooper Hawk, *Accipiter cooperi,* and the **Sharp-shinned Hawk,** *Accipiter striatus,* are the two other Accipiters that range over most areas of the United States. Their appearance is fairly similar as to color scheme—bluish slate above and barred with reddish brown below; but the Cooper hawk, which averages some seventeen inches in length, is about a third larger than the sharp-shin.

The farmer views both these birds with a jaundiced eye. The Cooper hawk frequently seizes half-grown chickens, dashing after these unfortunates with a dazzling speed that has earned it the nickname of "the Blue Darter." Both species, at least during the nesting season, often carry their prey to some favored log or branch where they

fastidiously snip off most of the feathers before devouring it. It is the bird-eating habits of these hawks that are responsible in large part for the implacable hostility of farmers and sportsmen towards all birds of prey.

All the Accipiters build sturdy nests of sticks, snugly lined with finer material, such as shreds of bark. The eggs of the goshawk and Cooper hawk are white or pale bluish, but those of the sharp-shinned hawk are handsomely marked with brown. Accipiters build a new nest each year.

The European Sparrow Hawk, *Accipiter nisus* (not to be confused with the American sparrow hawk, a falcon), is a relative of the sharp-shinned hawk. The European sparrow hawk is brave to the point of utter recklessness, for the bird will fly at almost any other creature of the air, no matter what its size. This trait makes the sparrow hawk valuable to the falconer if it can be properly trained. Unfortunately, however, the sparrow hawk is rather a dunce, being slow to learn a lesson and quick to forget it. The two smaller American Accipiters are afflicted with the same nervousness in captivity; not so the goshawk.

BUTEOS—NOT SO SPEEDY, NOT SO TRUCULENT

The many members of the genus *Buteo* are quite different from the Accipiters. Heavily built, with ample wings and broad tail feathers, they soar effortlessly for hours, barely moving their wings. They often perch patiently on an exposed stump waiting for their chance to pounce upon a rodent, frog, or snake. They rarely catch birds, which are too elusive for them.

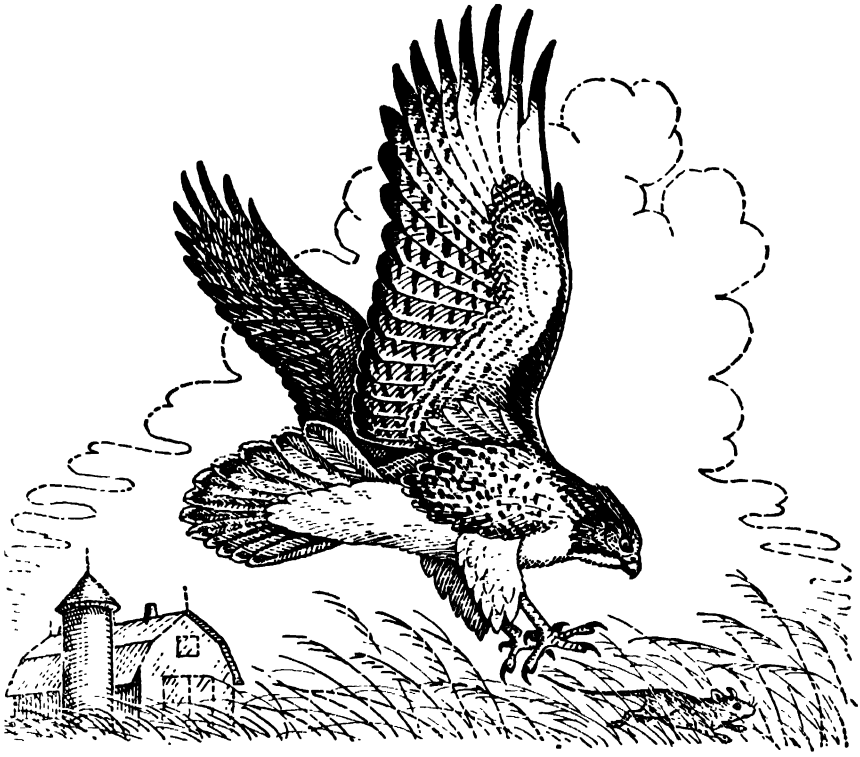
In the Old World the Buteos are generally called "buzzards," and it is a pity that this name, which distinguishes them from the bird-eating hawks of the genus *Accipiter,* has not been applied to the American species. Because the Turkey Vulture has received the name "buzzard," many of us find it unnatural to use this term for any other bird.

The best known of the American Buteos is the Red-tailed Hawk, *Buteo jamaicensis,* twenty inches long or more. We find this large, handsome species throughout the United States. The bird's shrill piercing scream is in keeping with the wild surroundings it favors.

BALD EAGLE SOARING

The bald eagle, or American eagle, the national emblem of the United States, is an imposing bird as it soars in tremendous circles high in the sky. As it turns, the sun glistens on its snow-white tail and head, the latter sometimes appearing bald and hence giving the bird the name of bald eagle. It is most common along the seacoasts, all the way from Florida to Alaska, where it lives largely on waste fish and other refuse, though at times it catches its own prey. Wherever it has not been killed off by thoughtless hunters, it is also still to be seen around large inland lakes, such as that shown in this picture. It builds its nest in some huge pine or other woodland giant and returns to the same nest year after year to lay its two or three large white eggs. The young birds are brown all over, lacking the white head and tail, which they do not acquire until they are several years old. When kept in large, roomy flight cages, the bald eagle has been known to nest in zoos. (Illustration by Galli, courtesy of the Weyerhaeuser Timber Company.)

Its nest, a large structure built in a commanding position in some lofty tree, is used year after year. The female lays two or three spotted eggs



AN ACCOMPLISHED GLIDER

A large, handsome bird, the red-tailed hawk is often wrongly accused of preying on poultry. It soars for hours without apparent effort on its broad wings. From time to time it utters a harsh scream.

The Red-shouldered Hawk, *Buteo lineatus,* a slightly smaller and less powerful bird, is partial to swampy woods and feeds on frogs for the most part. In the spring a series of clear ringing whistles calls our attention to this hawk as it circles above its home woods. Even in flight its white-barred tail is quite noticeable.

The **Broad-winged Hawk,** *Buteo platypterus,* a smaller, harmless, and unsuspicious bird, suffers greatly from thoughtless gunners. We can readily identify it by the rather broad band near the base of its

The broad-wing is a long-distance migrant. Soaring slowly southward in the autumn, it takes full advantage of rising air currents along ridges of the Appalachians. On suitable days a favorably posted observer may see hundreds of this species with lesser numbers of other hawks. The broad-wings fly low at certain points, and sometimes a great many are shot. We are now overcoming this practice, by education as to the value of these mouse-eaters, and by setting up sanctuaries at the worst danger spots, such as Hawk Mountain, Pennsylvania.

The Rough-legged Hawk, *Buteo lagopus,* winters in the northern United States. Some individuals are almost black, others much lighter. This wide range of color is typical of the Buteos. As for the name "rough-leg," it tells us that the legs of the bird are feathered right down to the toes. This may be an adaptation for the cold areas it lives in, though the legs of some tropical eagles are feathered in the same way. The name *lagopus* (meaning "rabbit foot") is also a reference to the feathered leg.

There are several additional species of Buteos in western and southwestern America, and still others in various parts of the world. One makes its home, for example, in the Hawaiian islands, another in the Galápagos Islands. This Galápagos hawk has lacked enemies of any kind until the relatively recent appearance of man on the scene. That is why the bird, like many other island animals, is so tame it can almost be caught by hand.

HARRIERS

The Marsh Hawk, *Circus aeruginosus hudsonicus,* is another widely distributed American bird of prey. The several European species of this genus are called "harriers," and many would prefer to see the American bird called the "marsh harrier." As you have noted in the cases of several other birds, the word "hawk" invites shooting almost as a matter of course.

We can recognize the marsh hawk at a great distance as it beats along open country; its wings and tail are long and narrow, and there is a conspicuous white patch on its lower back. The male is a beautiful pearly gray. In the spring he rolls and tumbles through the

air in graceful courtship performances. The female lays four or five whitish eggs in a flimsy nest on the ground beneath tall grass or low bushes in marshes or swales. Nesting on this kind of terrain, the marsh hawk has naturally suffered less than other hawks from the conversion of former forests to farm lands. The young, like the adult females, are brown.

EAGLES—LORDS OF THE AIR

The typical eagles belong to the genus *Aquila*, and may be identified by their large size and feathered legs. The outstanding representative of these superb birds is the famous Golden Eagle. You may be surprised to learn that the Bald Eagle, generally considered the most majestic of these birds, is not grouped with the "typical eagles." The bald eagle is classed among the sea eagles.

The Golden Eagle. *Aquila chrysaetos*, ranges over a large part of the Northern Hemisphere. This magnificent bird has a wingspread up to well over six feet. A heavy bird, it may appear a bit ponderous when it takes flight from a low elevation in quiet air. But once it is aloft, it soars majestically. It plunges after its prey with great force and velocity, and the sound of the air whining through its pinions can be heard for quite a distance.

The golden eagle snatches up many a rabbit and ground squirrel; but if the great bird is pressed by hunger, it may attack small lambs or turkeys. Observers have reported that eagles sometimes resort to the device of hunting in pairs; in at least one instance a number of them launched a mass attack upon a prong-horned antelope. The natives of the Asiatic steppes train the golden eagle to aid in hunting foxes and gazelles. So great is the strength of its talons that even when the falconer wears heavy gauntlets his wrist aches after an eagle has perched there.

At times this eagle has a taste for carrion. A pair have been observed feeding on a dead ox and keeping at a distance a flock of California condors—birds that are twice the eagle's size!

The golden eagle is blackish brown with an attractive golden sheen on nape and back that accounts for its name. Young birds have whitish areas in the tail. This eagle is one of the few birds, by the

way, that do not have at least one complete annual molt; instead, the molt takes two years. The bird places its nest in some elevated, inaccessible spot, either upon a ledge or in a large tree. It builds the nest of sticks, and uses it year after year. The birds apparently mate for life.

While the life span of eagles in the wild is naturally a matter for conjecture, we do know of a golden eagle that lived for forty-six years in a zoo.

In North America a few golden eagles are seen each fall at Hawk Mountain, Pennsylvania. However, this eagle has always been much more common in the western mountains and deserts. As for the birds seen in Pennsylvania, we do not know whether they nest in eastern Canada or come from the Northwest. Back in colonial days the golden eagle undoubtedly nested in the Adirondacks of New York and elsewhere in the eastern United States. The golden eagle still occurs with enough regularity in certain remote areas of the southern Appalachians to suggest to us that it breeds in that region; but to date, naturalists have not been able to confirm this theory.

TROPICAL EAGLES

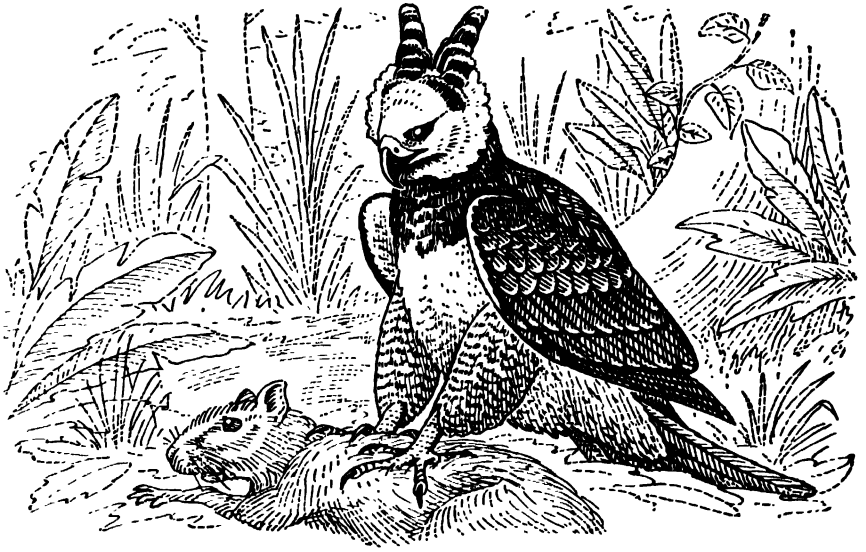
The great Harpy Eagle, *Harpia*, is well named after the hideous monsters of Greek mythology. (The mythical Harpies were half-woman, half-bird, with the nightmarish duties of seizing dead souls or snatching away the food of those accursed of the gods.)

The harpy eagle stands over three feet high. With its double crest, cruel face, and deadly hooked beak, it makes a horrifying impression. Its wicked-looking claws and powerful legs are unequaled by any other bird of prey in the world. The pearly gray plumage enhances its striking appearance.

Nesting at the top of a tree at a high elevation, the harpy eagle houses its young in a solidly built nest. The female lays two eggs. The slowly developing young have insatiable appetites. To keep them reasonably well fed, the parent harpy eagle flies out on those raiding forays that are the terror of the tropical forest. Zooming down with brutal force on monkeys, sloths, and large birds, the harpy eagle kills them with its sharp talons, and soars aloft with the lifeless body in its mighty grasp.

We have comparatively little first-hand information about the

harpy eagle's habits. Dr. William Beebe once had the experience, as rare as it was thrilling, of seeing no less than six of these great birds soaring together through a mountain pass in Venezuela.



AN EAGLE NAMED AFTER A MYTHOLOGICAL MONSTER

The well-named harpy eagle is just as formidable as it looks. Note the double crest, the emphatically hooked beak, the powerful talons. Monkeys, sloths, and large birds are the favorite prey of this ogre of the South American jungles.

The renowned Monkey-eating Eagle, *Pithecophaga,* of the Philippines, is another formidable creature, only a shade less powerful than the harpy eagle. It is brown and has a very long tail. With the crown of pointed feathers on its head, and its very high, narrow bill, this bird has a truly bizarre appearance. It feeds upon monkeys and other mammals and birds. The first monkey-eating eagle to be collected was captured on the island of Samar by the famous English collector, John Whitehead, who succumbed to jungle fever a few years later on the Chinese island of Hainan. The bird created a sensation, but it proved difficult to obtain additional ones.

This eagle is found on the island of Luzon, in the Beleete Pass area made famous by American troops. Its true stronghold, however, is on the great jungle island of Mindanao in the southern Philippines.

Still another notable member of this tropical group is the Serpent

Eagle, *Spilornis,* an attractive reddish-brown bird. This is a smaller and commoner species, found on the Asiatic mainland as well as in the Philippines. These birds often soar in pairs high above the forest, uttering beautiful, far-ringing whistles. The serpent eagle, as you might gather from its name, eats many a snake. It also feeds on mammals and birds.

RELATIVES OF THE GOLDEN EAGLE

We come now to a second group of tropical eagles, probably not closely related to the ones just discussed, though much alike in habits and appearance. The birds in this second group are related to the golden eagle, but with relatively shorter, more rounded wings. The difference takes on significance when we learn that this wing shape helps the tropical eagles to hunt their prey in forested country rather than in the open.

The African Crowned Eagle, *Spizaëtus coronatus,* is perhaps the most magnificent of these birds, and warlike African chieftains prize its feathers and huge claws, if only for their intimidating appearance. This bird feeds upon monkeys. The Pygmies, those strange, almost dwarflike natives who have no language of their own, sometimes find the eagle's nest and bring the young to collectors of live animals.

In this connection, Dr. James P. Chapin of the American Museum of Natural History told us this amusing story: "When Herbert Lang and I were on our expedition to the eastern Belgian Congo in 1910, the chief of one of the tribes wished to present us with his live crowned eagle, which we needed to complete a museum collection. As the easiest method of dispatching the formidable bird, we sprinkled some strychnine on a ball of meat. The eagle gulped this down and of course expired almost instantly. The old chief was tremendously impressed by this white man's magic and insisted upon having some of the potent powder, which he intended to keep in reserve for use upon his enemies. We gave him a small bottle of cornstarch and left before he had an opportunity to test its powers."

The related Martial Eagle, *Spizaëtus bellicosus,* is equally powerful, and more likely to venture away from the forest. Its two young are so pugnacious toward each other that eventually one gets the upper hand and kills its nest mate.

The American hawk-eagles are somewhat smaller, and less powerful. The Ornate Hawk-eagle, *Spizaëtus ornatus,* is handsomely marked with chestnut, black, and white. A related but more formidable species, Isidor's Crested Eagle, makes its home in the Andes, in altitudes up to eleven thousand feet. Adults are blackish chestnut, while the immature birds have a totally different color scheme: white below and light brown above. There was a time when, because of this difference, the young birds were erroneously described as a distinct species, called "de Ville's Eagle."

SEA EAGLES

The Bald or American Eagle, *Haliaeëtus leucocephalus,* is American, to be sure, but not bald at all—it only looks so from a distance. It is the best known of the American eagles and the national emblem of the United States. To most of the American Founding Fathers, the proud, independent spirit of this majestic bird seemed a fitting symbol of the young republic.

The adult bald eagle is a handsome bird with snow-white head and tail and dark-brown body. This bird stands three feet tall, and occasionally more; its wing spread is usually about six feet, though larger specimens have been known. It weighs between six and twelve pounds, and there is no scientific evidence for the legend that it has carried off children. This eagle's vision is so sharp that some observers credit it with being able to sight its prey at a distance of three miles!

Almost uniformly brownish, the young bald eagle does not fully acquire the grown-up plumage until it is several years old. That is why Audubon considered it a distinct species, naming it *washingtonensis* in honor of George Washington. The bald eagle ranges over North America as far south as Mexico. It has been much persecuted and is now commonest at the two extremes of its range, Florida and Alaska.

This eagle's nest is a huge mass of sticks, solicitously lined with finer materials for the benefit of the young. Repaired year after year, the nest eventually becomes a ponderous structure weighing more than a ton! Often the nest tree is killed and finally comes crashing to the ground. The bald eagle lays two or three white eggs. In Florida these eagles begin to repair their nests in the fall and may

NEW WORLD VULTURES

The family name of these birds, Cathartidae, means "cleansers." All the New World vultures are carrion-eaters and scavengers. While they are similar to their Old World namesakes, there are a number of differences in body structure. This has led some students to develop the theory that the New World vultures may have evolved quite independently of all other birds of prey.

The Turkey Vulture or Turkey Buzzard, *Cathartes aura,* is one of the most famous of the New World vultures. A repulsive bird at close range, the turkey vulture is a past master when it comes to flying. It is a familiar sight as it quarters effortlessly and gracefully over the countryside, with its long narrow wings held slightly above the horizontal. About thirty inches long, it has a notable wingspread—almost six feet, and a body weight of about two and three-quarters pounds. It has a fantastic flair for discovering small dead animals; whether or not its keen eyesight is aided by a sense of smell, is still a matter for debate. Once a vulture detects food and plunges to earth after it, we may be pretty certain that its fellows will not lag behind:

> First a speck and then a Vulture,
> Till the air is dark with pinions.

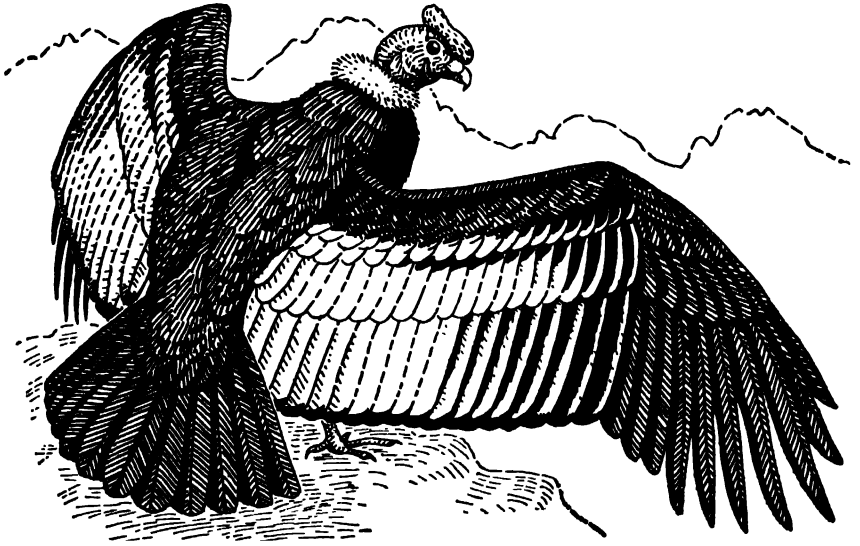
The turkey vulture's bare red head reminds us to some extent of a turkey's, hence the vulture's common name. It ranges from southern Canada to Patagonia, but within the United States it appears most frequently south of the Mason-Dixon line.

The turkey vulture lays its two spotted eggs in a hollow tree or log, a cave, or even under dense bushes—it does not bother to build a nest. The young are covered with white, woolly down. They have the disagreeable habit of vomiting up their last meal in the general direction of any intruder.

Captive turkey vultures have been known to live upwards of thirty years.

The South American Condor, *Vultur,* is one of two species of condors that are by far the largest of the American vultures. The South American condor is mostly a mountain species, soaring to altitudes of as much as twenty-five thousand feet, well above the highest peaks of the Andes. But the condor, magnificent flier that it is, also visits

the seacoast, where it devours the dead bodies of whales and dolphins or dines on the eggs of cormorants and boobies on the bird islands off Peru. The condor is less prone than any other American vulture to limit its feeding to carrion. At times it attacks calves and lambs.



A BIRD OF THE SNOWY MOUNTAIN PEAKS

Altitudes of twenty-five thousand feet are not unknown to the condor. This superb bird of prey has a ten-foot wingspread, second only to that of the albatross. Its impressive appearance is enhanced by its bold color scheme—red head and neck with black body plumage. It is a carrion-eating vulture but sometimes kills lambs.

The condor's color scheme is very striking—red head and neck, with black body plumage. The male has a large comblike growth on his head and a ruff of white down at the base of his unfeathered neck. Given its flying habits, we may take it for granted that this bird has amazingly keen vision. Said to be the largest flying bird, the condor has a wingspread of as much as ten feet. Only the largest albatrosses exceed this huge wing expanse.

The condor selects wild, isolated spots for nesting—high mountain crags or caves. The female lays two large white eggs, and the parents take turns brooding. In places where there are many caves, quite a few birds may assemble each night to roost. They are often shot for their wing and tail plumes.

You may be familiar with the technique used to capture these great birds alive. It is very clear and simple in theory, quite arduous in

practice. Condors are captured by leaving a carcass as bait for them inside a fenced enclosure. Once on the ground, they cannot gain enough momentum for flying without running a considerable distance and thus are unable to fly out of the small enclosure.

OTHER VULTURES

The Black Vulture, *Coragyps,* favors more southerly climes than the turkey vulture. Traveling in largish flocks as a rule, the black vulture is common in the deep South of the United States. As for Latin America, large flocks are on hand in every village, perching expectantly in shade trees, soaring overhead to check for the possible arrival of a tasty carcass, or making frequent visits to the familiar local sources of garbage or offal. The black vulture flies capably, though it lacks the turkey vulture's buoyancy. A heavier-set bird with short, broad wings, the black vulture is about twenty-seven inches long, with a wing spread up to four and one-half feet.

The King Vulture, *Sarcorhamphus,* of tropical America, is the most colorful of the New World vultures. Its body feathers are white with satiny gloss; the wings and tail are black. Its bare head, tinted with scarlet, lemon, blue, and violet black, is further ornamented with wattles. The effect is gaudy yet repulsive.

The California Condor, *Gymnogyps,* fully as large as its South American cousin, is known to surprisingly few people. There was a time when this great bird was common throughout much of the southwestern United States, and fossil remains have turned up in Florida. But the number of California condors was reduced so radically by shooting or by poison baits put out for wolves that today there are less than fifty of these birds in existence! They live in remote areas in the Sierra Nevada Mountains of California and are barely managing to maintain their numbers.

OSPREYS—FISHES' NEMESIS

The Osprey or Fish Hawk, *Pandion haliaëtus,* is a large bird—about twenty-four inches long, with a wingspread of some five and a half feet. Its flight is easy and elegant as it wheels gracefully over the water, and it has some very useful adaptations for catching fish.

On seeing a likely victim, the osprey hovers for a few moments and then plunges upon it with a mighty splash. The plumage of this bird's under parts is appropriately dense and compact to withstand the shock of striking the water. As you may imagine, it would ordinarily be no easy matter to seize and retain so slippery a creature as a fish. But here again, nature has provided the osprey with ideal equipment: long, curved claws that are exceedingly sharp. It is a pity that such admirable adaptation must sometimes go unrewarded; but, as we pointed out earlier, the eagle sometimes ruthlessly forces the osprey to part with its booty.

The osprey has certain features of body structure that set it apart from other hawks. These differences are of great interest to the naturalists, who have placed the bird in a family (Pandionidae) all by itself. The osprey's head and under parts are mostly white, with dark brown coloring for the upper parts. It breeds in all sorts of places. Commonest in coastal regions, it frequently nests on sizable rivers or lakes. A few pairs of ospreys make their home on top of the remarkable rock pinnacles in the canyon of the Yellowstone River.

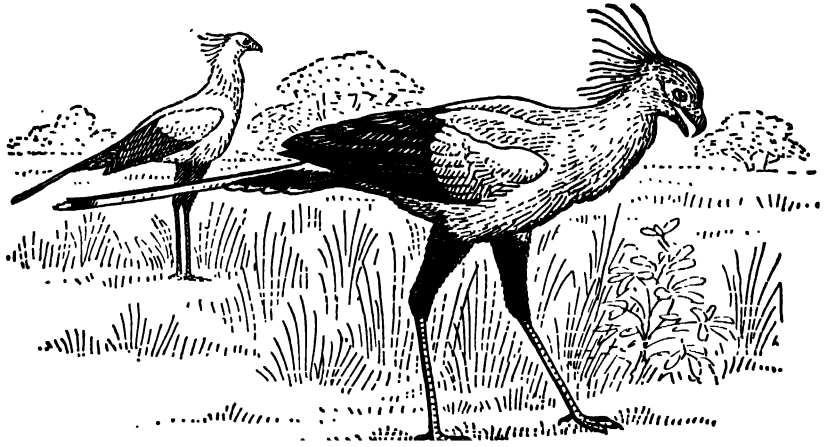
The osprey builds a large nest—sometimes on the ground, more often in a dead tree. Twenty or more pairs of ospreys nest on a deserted island at the mouth of the Connecticut River, most of them on the ground. The female lays three or four eggs, beautifully blotched with brown. In the British Isles, the eggs of the osprey were collected so avidly that the bird became extinct there.

SECRETARY BIRDS—MORE THAN A MATCH FOR VENOMOUS SNAKES

The Secretary Bird, *Sagittarius,* is an uncommonly interesting bird. The most obvious spur to our curiosity is, of course, how it got its common name. This bird has long plumes which project from the back of its head as quill pens once did from behind the ear of a secretary. Living in Africa, where it ranges over unforested areas, the secretary bird spends most of its time on the ground. It has very long legs and strides along the African veldt like a bowman—hence the scientific name *Sagittarius* ("archer"); the family name is Sagittariidae. Its color scheme is suitable for a secretary or an archer: slate gray and black.

While the secretary bird's bill of fare includes lizards, large insects,

small mammals, and young birds, it is best known for its snake-killing abilities. Its long scaly legs and loose plumage afford venomous snakes little chance of striking home. In South Africa the secretary bird is often tamed and kept about the ranches to aid in controlling snakes and rodents. On the relatively few occasions that it takes to the air, it flies well.



SNAKE-KILLER OF THE AFRICAN VELDT

A relative of the eagle, the secretary bird, named for the plumes that project from the back of its head, kills many a snake on the African flatlands. Ranchers often tame the bird because they value its services in reducing the number of reptile and rodent pests.

Chickens, Pheasants, Turkeys, Peacocks, and Their Relatives

IF THE TITLE of this chapter is your first intimation that the ordinary farmyard chicken and the glamorous peacock are cousins, you are likely to raise your eyebrows. And no wonder! The peacock is one of the most beautiful of all living creatures, yet some

of the pheasants—such as the aptly named Argus Pheasant—need not be ashamed of comparison with their showy relative. As for the turkey, it has a touch of the exotic or the festive in its origin, its very name, its association with the Pilgrims and with feasting and good times. But the domestic chicken—where does it fit into the picture? What bird is more ordinary, more colorless?

But the connection is there, and cannot be denied. All these birds had a common ancestor. Aside from that important point, forget for a moment the veneer of surface appearance, and reflect on these similarities: The birds in this order, the Galliformes, are usually plump of body and stout of limb, with small wings. They run rapidly if not far, scratching vigorously in leaves and dirt for food—mostly vegetable matter, though they also relish insects. Turkeys, for example, fatten up on grasshoppers in late summer. And, as we shall see, chickens may be ordinary, but they are by no means colorless.

In Latin, *gallus* means "chicken." The Galliformes and gallinaceous birds are merely chicken-like or fowl-like birds. These gallinaceous birds have many enemies, and perhaps to compensate for this they lay, as a rule, a large clutch of eggs. The appealing, down-covered chicks are able to follow their mother as soon as they hatch.

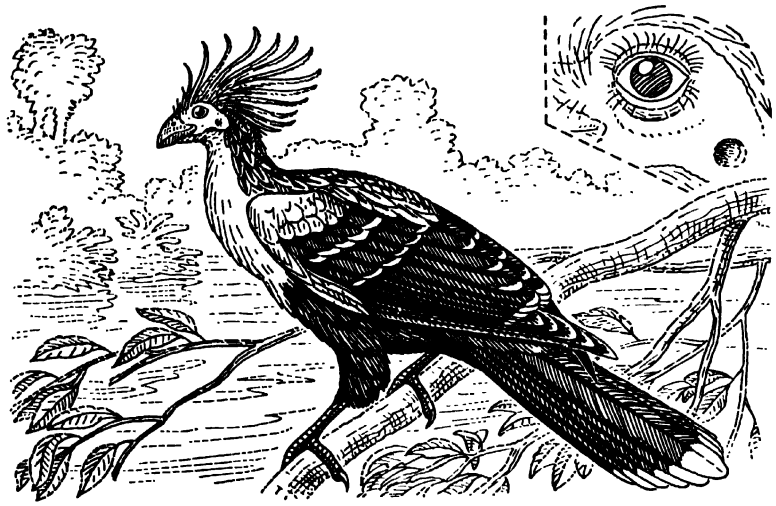
THE HOATZIN—"STINKING PHEASANT"

This peculiar bird lives in South America. The adult has a disagreeable smell which has earned it the name of "stinking pheasant" in British Guiana. Another strange feature is that it has eyelashes—a great rarity in birds. Naturalists classify the Hoatzin, *Opisthocomus hoazin,* with the fowl-like birds, though there is a theory that it may be distantly related to the cuckoos and turacos. About the size of a small chicken, the hoatzin has a small head, a slender body, and a long tail. Its back is olive brown, barred with white; its breast, buffy white or reddish brown.

The hoatzin, the sole member of the family Opisthocomidae, lives on the borders of sluggish tropical rivers. It slinks through the dense growth in a series of hops, but flying is a real chore, accomplished only with a laborious thrashing of wings.

The nest of this bird is a crude structure of sticks in a low tree above the river. The female lays from three to five buffy eggs flecked with red or purple. The young are remarkably precocious and versa-

tile: They have open eyes when they hatch and they are able to crawl with the aid of two reptile-like claws which grow on the "hand" of each wing. But this is not all—if frightened, they dive and swim under water, later returning to the nest by crawling up the trunk and limbs in lizard-like fashion.



THE REMARKABLE HOATZIN OF SOUTH AMERICA

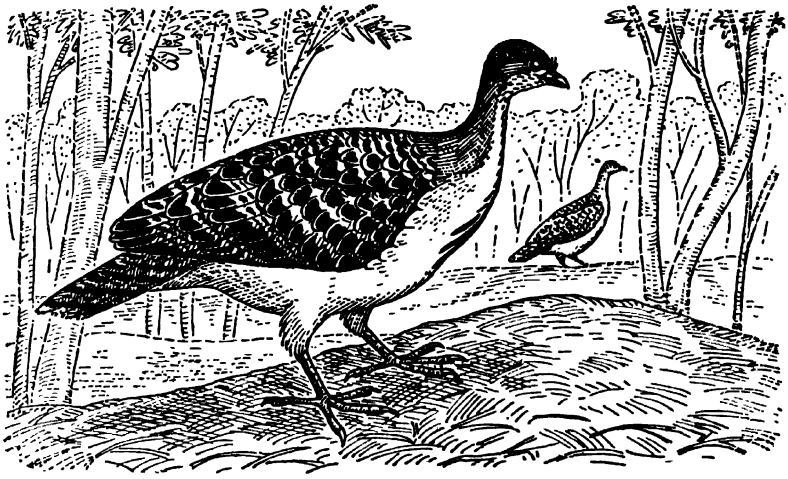
Nicknamed the "stinking pheasant," the hoatzin is one of the very few birds that have eyelashes (*shown in detail*). Not much of a flier, it generally keeps to dense jungle undergrowth. Young hoatzins have claws like the lizard's—with these they are able to climb tree trunks to escape from enemies.

MEGAPODES OR BRUSH-TURKEYS—EXPERT INCUBATORS

The remarkable Mound Builders or Megapodes ("big feet") are shy fowl-like birds of the tropics of the Australian region and the East Indies. These birds are expert at improving on nature's recipe for incubation. Sometimes they utilize the heat of the sun, other times the warmth generated by decomposing matter or else the heat of volcanic sands! No other bird has mastered these techniques.

To anyone who observes the huge mounds of soil and debris kicked and scraped together by these birds to contain their eggs, the usefulness of their strong legs and claws is obvious. On one of our expeditions, an old-time collector of birds of paradise showed us a

mound that was six feet high and forty feet in diameter. We estimated that the mound contained a good twelve tons of earth! Yet the birds had deserted it many years ago, and its size at that time must have been even greater. In Australia such megapode nests have been mistaken for native burial grounds.



THE MOUND-BUILDING MEGAPODE

Not content with nature's incubating methods, the megapode, a bird of the Australian region, builds its own incubator. This is a mound of vegetation, sometimes exceeding twelve tons in weight and forty feet in diameter. Well equipped for such a laborious task, the megapode has sturdy legs and strong claws. The species shown above is the mallee fowl or leipoa. About two feet long, it has black, gray, brown, and white plumage.

Naturalists believe that the decaying vegetation in the mound helps warm the rough-shelled brown eggs, which require about forty days to hatch. In the Solomon Islands the resourceful megapodes lay their eggs in volcanic sands warmed by heat coming from under the surface of the earth. Young megapodes are able to fly as soon as they hatch, and are left by their parents to fend for themselves. The grownups have quite a bit of bare skin around the head and neck. Some kinds have wattles on the neck, and during the breeding season the bare parts of the head often take on a bright coloring.

Megapodes—they are all grouped in the family Megapodiidae—are most abundant in New Guinea and Australia, where eleven of the

twenty known species occur. Others range as far west as the Nicobar Islands and as far north as the Philippines.

When it comes to flying, megapodes are heavy and sluggish. They flush noisily from the ground and flap a short distance to an exposed perch before coming down to earth to hide. In New Guinea we found that megapodes keep to the ground unless sharply startled—as, for example, by the discharge of a gun.

At four thousand feet in the Owen Stanley Mountains we encountered the Maroon-rumped Megapode, *Aepypodius arfakianus*, a blackish bird with maroon on its upper tail. It has long powerful legs, honey-yellow eyes, a gray and apple-green face, and wine-colored comb and neck wattles. Upon entering the lower country near the Papuan coast, we observed that the smaller Scrub Turkey, *Megapodius freycinet,* became the common species of the family.

CURASSOWS, GUANS, AND CHACHALACAS

The dense jungles of tropical America are the home of this distinctive family of fowl-like birds. Of the thirty-five species, only one ranges as far north as the United States. These birds have a certain amount of resemblance, probably superficial, to the megapodes of Australia. On the other hand, the Cracidae, as these New World birds are called, prefer to live up in the trees rather than down on the ground like most of their relatives.

These jungle fowl build their nests of sticks, grass, and leaves in bushes or trees. They lay two to five rough-surfaced eggs. The young are able to run as soon as they emerge from the shell; they take on the dress of the grownups once they have shed their downy covering. Male and female are colored alike.

Though all attempts to domesticate the jungle fowl have failed, several species have been bred in captivity and young have been reared. However, after a generation or two of captivity, they cease reproducing.

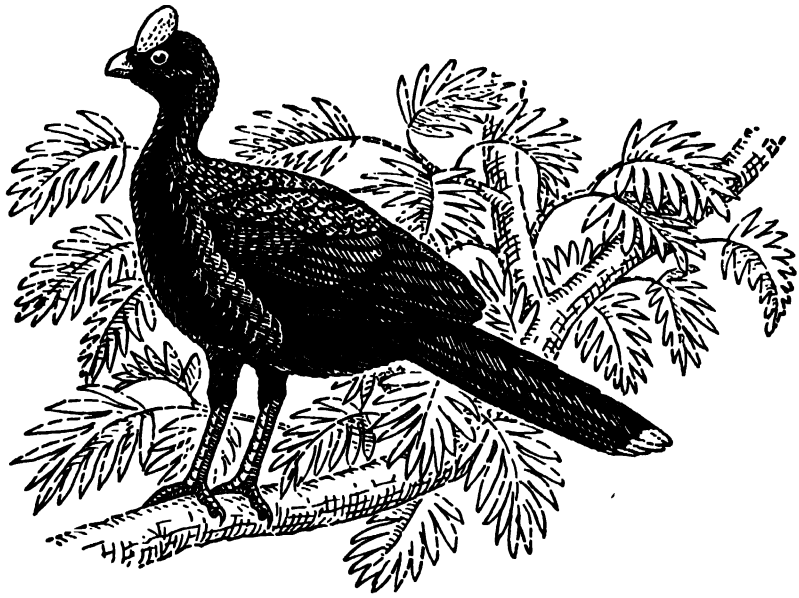
Again and again we have found curassows and guans thinly distributed or rare in areas inhabited by man. Apparently these shy creatures do not take kindly to humans. We have observed, however, that in that rarest of environments, the truly virgin forest, the spectacular, delicious jungle fowl are among the commonest of birds. Indeed, the forests of Central and South America are capable of sup-

porting vast numbers of these birds under favorable conditions. The members of this family feed on buds, leaves, fruit, insects, mollusks, and worms, of which an infinite quantity is available.

Here is an instance of the abundance of guans in virgin areas: In the Macarena forests of southeastern Colombia in the dry season of 1941, we watched thirty-seven Piping Guans, *Pipile cumanensis,* fly across a small jungle river in a matter of ten minutes as they streamed from one feeding tree to another.

CURASSOWS

One of the most familiar sounds of the South American jungle is the deep resonant honk that the Curl-crested Curassow, *Crax alector,* utters while feeding. About the size of a small domestic turkey, it is a great blackish bird with a white abdomen, a coral-covered cere (bill base), and a queer-looking crest made up of long twisted feathers. This headgear, which might serve for a Paris creation, gives the bird its popular name.



SHY DENIZEN OF THE JUNGLE—THE HELMETED CURASSOW

The curassow is a fowl-like bird of the American tropics. Usually found with its mate in the treetops, it descends to feed on the cool forest floor during the hottest part of the day. Thus far, all attempts to domesticate the curassow have failed.

Though curassows spend much of their time in pairs at tops of trees, they always come down to the forest floor during the heat of the day to do their feeding. On one occasion we imitated the honk by blowing over the neck of an empty bottle! This deceptively convincing sound prevailed upon feeding birds to walk toward our hiding place. At such times they move slowly, pausing to feed, then snapping the head high to peer around, and all the while answering the deep notes.

Some curassows are helmeted, with a bladelike or nutlike casque on the forehead. One of these, the Cashew Bird, *Pauxi,* has a casque that resembles a large up-ended cashew nut. It dwells in the Andes from Venezuela to Peru.

GUANS

In the tropical forests of southeastern Colombia we were often amused by the sight of the White-crowned Piping Guan as it hopped down from the crown of the forest to low limbs overhead to examine us. All the while it emitted a plaintive "peep" exactly like that of a barnyard chick.

This species, which makes its home in northern South America, is fairly typical of the many guans living in Central and South America. Some twenty-eight inches long, it is a deep glossy green above, with a white crown and hind neck, a pronounced white crest, and a naked, slate-blue throat. Its shoulders and chest are delicately flecked with white. The greater upper wing coverts (special feathers covering the wing quills) form a broad bar of pure white.

At an altitude of four thousand feet we came upon the Wattled Guan, *Aburria aburri,* which is rather a stranger in these forests. The birds move almost soundlessly through the treetops, usually in pairs, feeding stealthily on small berry-like fruits in the company of gaudy tanagers. The wattled guan is deep glossy green above, with a noticeable crest and a long broad tail. The unusual outer primary wing quills are sharply curved and wirelike. The bird gets its name from the slender yellow wattle, about two inches long, that hangs from its neck.

CHACHALACAS

Chachalacas, the noisiest, smallest, and most numerous of the jungle fowl, are named more or less after their resounding call, "cha-cha-la-ca." Often they scream in chorus from tall perches.

The Common Chachalaca, *Ortalis vetula,* which ranges from Texas to Nicaragua, is fairly typical of the chachalaca tribe, long-tailed birds about the size of a pullet. Dark bronzy olive above, it is buffy olive below, with a short black bill and long slender legs. Its throat is framed by a pair of naked reddish streaks. The long tail is rounded and has whitish tips.

Chachalacas live in thick chaparral on the forest edge, and in the lower portions of clumps of bushes bordering streams and rivers. It is hard to see these birds because they have a habit of dancing off through the low underbrush after taking a quick look around. Mexicans sometimes have a tame chachalaca, which follows them about and perches at night beside the door of the family hut.

THE PHEASANT FAMILY: FROM PEACOCKS TO CHICKENS

This attractive family is notable for its colorful variety. As you will see, it ranges all the way from the breathtakingly beautiful peacock to the unglamorous farmyard chicken, and from the large pheasants to tiny quail scarcely bigger than a sparrow. It is in the Orient and India that the pheasant family, known as Phasianidae, have had by far their greatest development. Though none of the typical pheasants are native to the Americas, quails are well represented in the Western Hemisphere.

QUAILS AND PARTRIDGES—SPORTSMAN'S FAVORITES

The Bobwhite, *Colinus virginianus,* gets its common name from the male's clear whistled call, "bob-white." What harm this bird does to crops is greatly outweighed by its feeding on insects and weed seeds. So, on balance, the bobwhite is the farmer's friend. However, as it makes delicious eating, it is a favorite with hunters—so much so that it has had to be protected by game laws which limit the hunting season to a month in autumn. But man is by no means the bobwhite's only enemy. It is also often a victim of attack by foxes, skunks, and

weasels—not to mention the sharp-shinned hawk and the horned owl. Snakes, after killing bobwhites, swallow them whole. What makes the bobwhite particularly vulnerable is that it lives mostly on the ground, rarely taking to the air.

This bird does not migrate. During the wintertime it suffers severe hardship from cold weather and lack of food. It therefore comes as no surprise to us that its numbers have been considerably reduced in the northern United States.

Doubtless you have wondered at the difference between a quail and a partridge. There is no difference! In northern regions this bird is called a "quail," and in the South a "partridge." About ten inches long, the bobwhite is a chubby bird with beautifully mottled brownish plumage that blends well with the grassy fields or brushland where it lives. It is the only member of the family to make its home in the eastern United States.

Like the other American quails, the bobwhite is usually monogamous. The male has been known to look after the chicks if his mate meets with a mishap. The hen hides her nest in a clump of grass and lays as many as fifteen white eggs. (A pair may raise two or three broods in one year.) The young are very small at hatching time but, like all other young of this family, they are covered with down and follow their mother around as soon as they escape from the shell.

Except in the nesting season, bobwhites are highly sociable birds. They like to band together in flocks and coveys. At night the members of the covey roost on the ground in a circle, bills pointing out and tails pointing in. Thus they are ready to burst into flight, like small bombshells, at the approach of an enemy.

The European Common or Migratory Quail, *Coturnix coturnix,* is one of the few migrators of the entire family. Smaller than the bobwhite, it averages about seven inches long. It is mainly brown and black, with contrasting white and buff. Large numbers of these plain-colored little birds are netted for the table as they migrate through Italy and other Mediterranean countries.

The European Gray Partridge, *Perdix perdix,* flies very swiftly, bursting into the air with a noisy clattering of wingbeats. (There is a theory that the Greek word *perdix* approximates the clattering sound.) This partridge is a handsome, medium-sized gray bird with a chestnut tail. It was widely introduced into North America under the name of "Hungarian Partridge." Though it failed to thrive in

the East, it became an abundant and important game bird in the wheat country of western Canada.

SHORT-TAILED PHEASANTS—COLORFUL ASIATIC BIRDS

The Impeyan Pheasant or Monal, *Lophophorus impeyanus,* is, in the opinion of some naturalists, the world's most brilliant bird. Its back is a deep bronze and reflects almost every color of the rainbow when viewed from different angles. (It gets its name from Lady Impey, who tried to introduce it into England.) On its home grounds this striking bird ranges from Afghanistan eastward almost as far as Tibet.

The Impeyan pheasant is one of the short-tailed pheasants, a group which provides a transition from the quail and partridges to the true pheasants. Another notable short-tailed pheasant is the Blood Pheasant, *Ithaginis cruentus,* a native of the wild mountain country of western China. Its plumage is streaked with a bizarre mixture of grass green and bright red.

Related to the blood pheasant, but even more colorful, are the several species of Tragopans found in the same general region and in the Himalayas. The Satyr Tragopan, *Tragopan satyra,* of the Himalayas is deep cherry red, varied with white and brown. The cock has large areas of bare blue skin on its cheeks and two finger-like wattles of the same color behind its eyes. During courting these areas become very noticeable as they swell up with blood.

TYPICAL PHEASANTS

We come now to the more typical pheasants. The cock usually has a long pointed tail, or else the tail is arched as in the domestic fowl. Often he has a crest on his head, as well as wattles, or combs of bright bare skin. The hen, as you might expect, is usually much duller in color. A demure brownish bird, she is not too noticeable as she broods on her eggs or, later on, leads her dozen or so downy chicks through the fields.

Most pheasants have more than one mate, and the males are often armed with long sharp spurs for attacking their rivals. The cocks display their beautiful plumes to the hens in elaborate and ingratiating poses. They also crow and flap their wings, partly to scare off

rivals, partly to impress the hens. It is this behavior of the males that has made them popular symbols for boasting and "showing off." When we say that somebody "crows," there is no mistaking our meaning.

Pheasants are favorite game birds. As they are polygamous, their numbers are not seriously affected by hunting. Even a considerable reduction in the number of males does not reduce the output of young birds the following year. Despite his brilliant plumage, the cock pheasant is anything but an easy victim for the hunter. The bird trusts to his strong legs whenever possible and is resourceful in dashing through brier patches or hiding in any other cover that may be available. When he does take to the air, it is with a roar of wings and loud cackles of alarm that often unnerve the gunner into making a poor or delayed shot.

None of the typical pheasants are native to the Americas. However, the Common Pheasant, *Phasianus colchicus,* has been widely and successfully introduced into the United States from Asia and eastern Europe. The ring-necked variety is commonest in America. It has a distinctive white marking which does not appear on the English pheasant, believed to have been introduced into the British Isles by the Romans.

The male Ring-necked Pheasant is a beautiful bird, with golden red, purple, and yellow hues standing out in his varied color scheme. He also has a scarlet area of bare skin around the eye. His handsomely barred tail feathers are used in tremendous quantities by the millinery trade. Still, wise conservation policies have maintained his numbers.

The Reeve Pheasant, *Syrmaticus reevesi,* of northern China, is closely related to the common pheasant and even more striking in appearance. The male is often over eight feet long—due to the great length of his tail! Many of this pheasant's feathers are a gorgeous shiny yellow, mingled with black. Naturalists have placed eggs of the Reeve pheasant in nests of the common pheasant in New York State, but these attempts at introduction failed.

The familiar Golden Pheasant, *Chrysolophus pictus,* is one of the most brilliant of this eye-filling group. (Its colors include golden yellow, scarlet, green yellow, and black.) Unfortunately, this pheasant is threatened with extinction in the restricted parts of China where it still exists as a wild bird. However, it is a familiar species in zoos.

The Lady Amherst Pheasant, *Chrysolophus amherstiae,* is closely related to the golden pheasant. Their appearance is quite different —the one feature they have in common is a large ruff of ornamental feathers on the neck. The Lady Amherst pheasant's plumage is mainly white, green, and satiny black. These colors are blended so harmoniously as to satisfy the most exacting critic.

PEACOCKS AND THEIR RELATIVES—NATURE AT HER MOST FLAMBOYANT

The Peacock, *Pavo cristatus,* is famous for a display with the wonderful feathers of its long train that for sheer magnificence is not matched by any other bird. This applies only to the male; the female is plain in comparison, and has no train.

In this most flamboyant of all courtship displays, the male lifts and extends his train in a dazzling fan made up of iridescent golden and green feathers, adorned with elaborate ocelli ("eye-spots") of blue. These, by the way, are not his true tail feathers, which are blackish and hidden by the display. Incongruously enough, the peacock has a disagreeably shrill cry and ugly feet. We are reminded of Bacon's dictum that "there is no excellent beauty that hath not some strangeness in the proportion."

As the saying "proud as a peacock" suggests, this vain bird is very much aware of his own beauty. He will often go through his elaborate performance for admiring humans just as willingly as for his modestly colored mates.

The peacock is native to the East Indies and southeastern Asia, and in some Eastern countries it was customary to wear a peacock feather as a mark of rank. The folklore of many lands has allusions to the peacock—an indication that the bird was domesticated centuries ago.

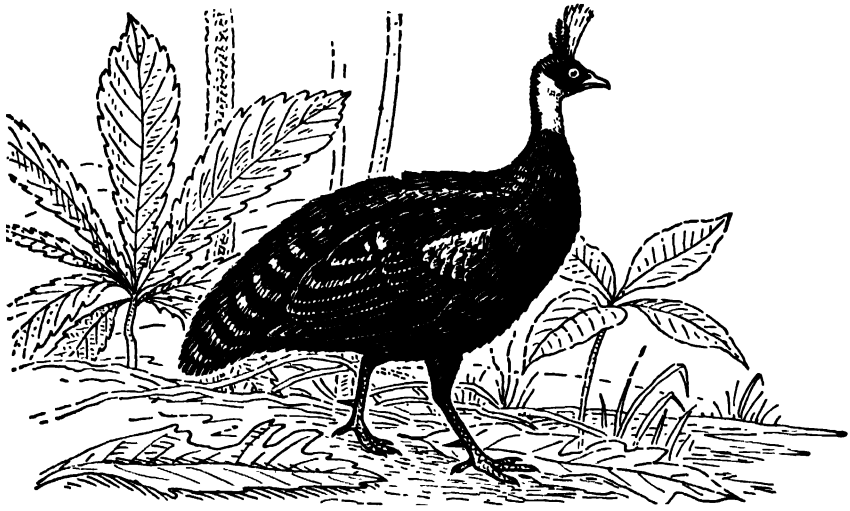
The Argus Pheasant, *Argusianus argus,* of Borneo and adjacent regions, owes its name to a famous legend. In Greek mythology Argus was the son of Zeus and Niobe. A monster with a hundred eyes, Argus was ever vigilant until Hermes cast a spell upon him and slew him. Thereupon jealous Hera, the wife of Zeus, used the monster's eyes to adorn the peacock.

The Argus pheasant's vanity sometimes results in its death in rather

a gruesome manner. The male Argus pheasant chooses a flat area in the jungle for his display ground. From it he carefully removes every leaf and twig to show off his plumes to the best advantage. The Dyaks and other native tribes stick razor-sharp bamboo splinters in this display ground of the Argus pheasant. Attempting to remove these splinters, the bird often cuts its throat and bleeds to death. In the Argus pheasant, by the way, it is the inner wing feathers that are lengthened and marked with beautiful eye-spots.

The magnificent Ocellated Pheasant, *Reinardia ocellata,* offers us still another kind of specialization. The male has two central tail feathers that are four inches broad and six or more feet long. Naturalists know of two races of this bird: one from Indo-China and the other from the Malay Peninsula. Both live in dense foliage and are very secretive. That is why only a few specimens were available until Captain Jean Delacour, the well-known authority on birds, succeeded in bringing back a number of live birds from Indo-China.

The Congo Peacock, *Afropavo congensis.* For a long time naturalists believed that all the typical pheasants are natives of Eurasia or the East Indies. In 1936, however, Dr. James P. Chapin, the foremost



THE CONGO PEACOCK—"BIGGEST BIRD NEWS OF THE CENTURY"

For centuries scientists assumed that there were no peacocks in Africa—their known dwelling places were the East Indies and southeastern Asia. The belief of the naturalists was shattered in 1936, when the Congo peacock was discovered in the Belgian Congo.

authority on the birds of the Belgian Congo, startled the scientific world by describing an African species, the Congo peacock. This discovery has been acclaimed as "the biggest bird news of the century."

As early as 1913, Chapin had found two or three feathers of an unidentified pheasant-like bird, in the headdress of a Congo chieftain. Many years later he discovered that two old mounted birds in a Belgian museum, long believed to be young peacocks, were really examples of an undescribed peacock-like pheasant living in the Belgian Congo. Hastening to Africa, he soon succeeded in bringing back some of these birds—Congo peacocks. The male of this species is largely gleaming black with an ornamental tuft of white plumes on its crown. The brown and green female has an even more obvious resemblance to the peacock group of pheasants.

The Congo peacock was probably once widely distributed throughout the Congo jungles. However, the Pygmies trapped it out of so many large areas that it is now uncommon. This explains why naturalists were unaware of its existence for so many years. In 1948, Mr. Charles Cordier made a trip to the Congo primarily to secure living Congo peacocks. He returned to New York the following year with several of these splendid birds for the Zoological Park.

DOMESTIC CHICKENS—BIG BUSINESS

The domestic chicken, probably the first bird ever domesticated by man, is the basis of a billion-dollar industry in the United States. In terms of human food of animal origin, poultry husbandry is second in importance only to dairy products. The chicken can offer lively competition to the dog for the proud title of "man's best friend." Aside from mere money value, the chicken's meat and eggs are two of our staple foods.

The Old World stories of the "Little Red Hen" and "Chanticleer and the Fox" are very ancient. Early Chinese records indicate the chicken was introduced from the "west" about 1,400 B.C. The bird was known to the Greeks as well as the Romans, who introduced it into the British Isles. Even the Polynesians of Tahiti and the remote islands of the Pacific relied on poultry for much of their food. The New World, however, had no domestic fowl until they were brought in by the Spaniards. (On the other hand, the Americas had the tur-

key, which was unknown in the Old World until the Spaniards introduced it into their homeland from the new colonies.)

Many Kinds of Chickens. Nowadays we recognize dozens of varieties of chickens. Diverse as they are in size, appearance, and uses, they are all descendants of one species: the Red Jungle Fowl, *Gallus gallus*, of India. These breeds owe their origin to patient selection and development by man for desired traits and qualities. Flesh, feathers, eggs, strength, aggressiveness—all these are items that have entered into the breeder's calculations.

There are two main categories of these fowl: utility breeds and show or fancy breeds. To these we might perhaps add a third: the fighting gamecocks, which through the ages have been a symbol of courage. *Gallus* is so pliable that the breeder can produce new strains with relative ease and rapidity. Consider the startling contrasts among these strains, all of which are believed to have come from one species. Compare the massive Brahma (twelve pounds) with the delicate Bantam (twenty ounces), the long-tailed Yokohama (tail up to twelve feet) with the tiny cushion-tailed Cochin, the flashing plumage of the spangled Hamburg with the drab Orpington.

Of the commercial varieties, the White Leghorn is most specialized for laying eggs—indeed, it is hardly more than an egg-laying machine! (This breed was introduced into the United States from Italy about 1835.) Properly cared for, White Leghorn hens lay one egg a day almost throughout the year. They have almost lost the instinct of broodiness and incubating, and production of another generation of hens is taken care of by artificial means—in incubators and electrically heated "brooders." The male chicks of these egg-laying breeds can get to be "a drug on the market." Usually they are well fed until they are three or four months old and then sold as "broilers."

Farmers who keep a small flock of chickens for their own use, select a breed that combines good egg-laying with large size—an assurance of better table qualities. Two of the best breeds of this type, the Rhode Island Red and the Plymouth Rock, are supposed to be of American origin.

When we come to ornamental fowl, we find that their number is legion. Many of the most attractive belong to the dwarfs, or Bantams, and for their initial development we are indebted to the natives of

the Bantam section of the island of Java. A little familiarity with these breeds reveals a remarkable range of color differences. Another striking distinction is the presence or absence of ornamental tufts of feathers on the legs and other parts of the body. We observe that the feathers may be spangled, lacy, vermiculated (marked with irregular wavy lines), barred, solid or striped; they may, and they do, vary from rose to delicate iridescent violet—or again, they may be silky, cottony, or frizzled. Ornaments—combs, for examples—are of every shape from nail-like spikes to complicated leaf- and beardlike appendages.

Cockfights. In zoos and on game farms, Bantam hens are used to hatch out pheasant eggs and to rear the young pheasants. The hens have a quiet, confiding nature which is very suitable to this task. What a contrast to the fighting cocks!—a breed selected for strength and vicious qualities. Long-legged, rangy creatures, the roosters are carefully trained to fight to the death. And a fight to the death it is, for they inflict cruel wounds in their gory duels, striking out with their wings, inflicting gashes with their leg spurs, and seizing on vulnerable spots with their beaks. The ability of gamecocks to fight on with mangled and bleeding bodies has given us the adjective "game," in the sense of willingness to fight against great odds.

This "sport" affords the spectators such a powerful feeling of fascinated horror and delight that it has survived to some extent its outlawing in the United States and Great Britain. Elsewhere—the Philippines and in some parts of Latin America, for example—betting on cockfights is as popular as betting on the horses is in the United States and the British Isles.

TURKEYS—WILD AND DOMESTICATED

The Wild Turkey, *Meleagris gallopavo,* is a Vanishing American. Time was when it roamed over vast stretches of North America—from New England, where it was especially plentiful, south over most of the Mexican plateau. The Pilgrim Fathers were able to celebrate the first Thanksgiving with a wild-turkey dinner, and even in the early decades of the nineteenth century this "noble bird" commanded prices of from six cents to a quarter. Yet, by 1840 the once abundant wild turkey had been exterminated in New England and

New York. Mt. Tom in Massachusetts was named after an elusive old tom gobbler that lived there for many years and may have been the last of his tribe in that state.

Turkeys are magnificent birds. The male is a good three feet tall, with an average weight of about twenty pounds. Its feathers have a metallic luster reflecting brown, reddish, and green—to mention only the predominant colors. With its small, naked head, long neck, powerful legs, and big feet, it is particularly impressive looking when it makes a fanwise display of its wide tail feathers at courting time.

Nowadays the wild turkey occurs in stringently limited numbers from southeastern Pennsylvania to Florida wherever it can seek sanctuary from gunners in sufficiently large tracts of wild country. It also makes its home in a few areas in the Southwest and in Mexico. Enjoying considerable conservation protection, this bird will hold its own if given half a chance: it is extremely wary, and at the first sign of danger it dashes off at high speed. It can also fly well when necessary—its wingspread averages forty inches.

The wild turkey gobbler, like his domesticated cousins, is famous for his pompous strutting and gobbling. The hen hides her nest with great care, concealing it not only from enemies but from her jealous spouse as well. The gobbler is polygamous, keeping a sizable harem. During the mating season he is so busy fending off rival males that he has little time for eating. Forest "mast" (chestnuts, acorns, and the like), especially plentiful in autumn, makes him pleasantly plump, and devouring insects also helps.

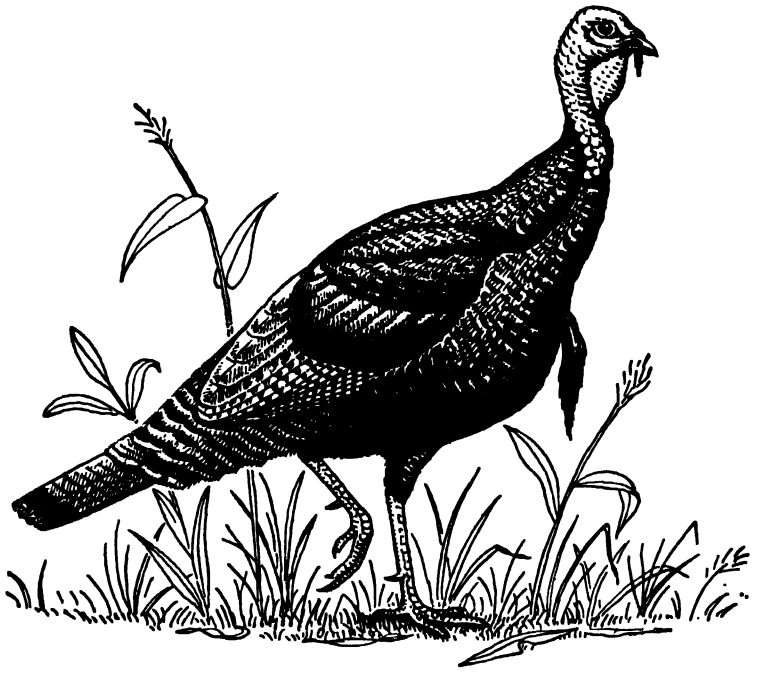
The wild turkey has a variety of calls, mating and otherwise, and the Indians were of course past masters in imitating the calls as part of their hunting technique. The modern hunter also resorts to imitation, but he has fewer targets, and they are sadder and wiser. The Indians, by the way, named the turkey after its most obvious trait: "the-one-who-gobbles."

The life span of domestic turkeys is short for obvious reasons. We have applied modern design to breeding them: smaller frames with meatier breasts, so that they take up less oven space. The wild turkey has a life span which is short because of its many enemies—five years seems a reasonable estimate. The hen lays about a dozen buffy, lightly spotted eggs. Until able to fly, the chicks are menaced by a host of enemies. Worse yet, they are exceptionally vulnerable to damp, in-

clement weather. As a consequence, the hen is lucky if she succeeds in bringing half of her brood to maturity.

There is only one other species in the turkey family (Meleagrididae), the Ocellated Turkey, *Agriocharis ocellata;* it dwells in the lowlands of Costa Rica and nearby parts of Central America.

The Turkey's Interesting History. Both these species are related to the pheasants and may be the descendants of some member of the typical-pheasant group that long ago succeeded in reaching the New World. Long before Columbus arrived in the Americas, the Aztecs of Mexico had domesticated the turkey, and from this stock the various domestic breeds have developed. In the early decades of the sixteenth century, the Conquistadores brought back turkeys to Spain. Later on, the bird was reintroduced into the New World by Europeans.



A NEW WORLD BIRD WITH AN OLD WORLD NAME

The turkey was domesticated by the Aztecs long before the coming of the white man to America. The Spaniards brought this bird back to Europe, and still later it was reintroduced as a domestic bird into North America. The wild turkey is a stunning bird, three feet tall, with a forty-inch wingspread and a dazzling fanwise display of iridescent feathers.

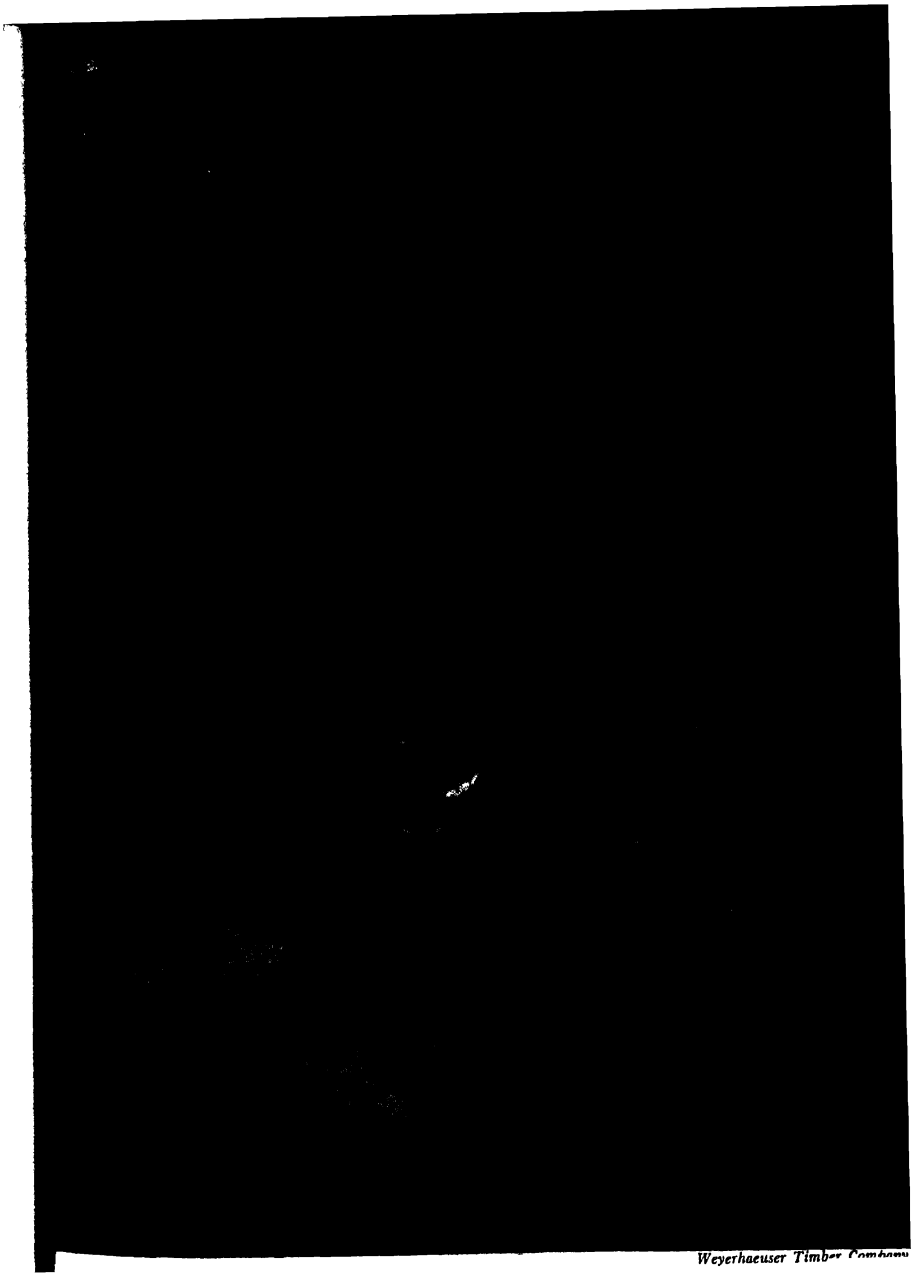
Tracing the origin of this New World bird's Old World name has detective story elements. As we have seen, the turkey is strictly a New World bird—even the turkeys brought from Europe were descendants of American turkeys. However, back in the sixteenth century, the turkey was confused in Europe with the guinea fowl, which had been imported from Africa via Turkey into the Spanish dominions and was referred to as a turkey. (In this connection it is interesting to recall the scientific name of the turkey family—Meleagrididae. In Greek legend, the sisters of Meleager were transformed into . . . guinea fowl!) Incidentally, some experts trace back the turkey's name not to Turkey, but to the bird's call of "turc-turc-turc."

GUINEA FOWL

In ancient times, the Romans considered guinea fowl a great delicacy, while the Greeks used these birds in sacrificial ceremonies. Centuries later, as we have just seen, the guinea fowl, which are of African origin, were confused with the turkey. Guinea fowl are plump birds, active afoot, but rather weak when it comes to flying. They have a pleasing polka dot plumage pattern and are grouped in the family Numididae. The most striking member of the family is the Vulturine Guinea Fowl, *Acryllium vulturinum;* the bare skin of its head is livid colored, like that of some vultures. Another species, *Numida meleagris*, the common guinea hen, has been domesticated but still retains much of its wild nature. In certain areas like Jamaica in the West Indies it has taken to the wild again and is hunted as a game bird.

GROUSE—NORTHERN GAME BIRDS

The true grouse make up still another family (the Tetraonidae) rather closely related to the pheasant family. Excellent eating and eagerly sought by sportsmen, grouse are mainly ground-dwellers and favor the northern latitudes. Most of them are handsome birds of medium or even large size. With the possible exception of the ptarmigan, they are polygamous. The males have elaborate courtship performances—some species perform their love dances on communal display grounds or "leks." Here the females come to mate and then leave to seek a hidden spot for their nest. The hen brings up the young by herself.



A HEN RUFFED GROUSE WITH HER NEWLY HATCHED CHICKS

The ruffed grouse, which is sometimes called the king of upland game birds, is found throughout the northern half of the United States, but is commoner in the east than in the west. In April or May the hen grouse lays from eight to twelve unspotted, buff-colored eggs in a carefully concealed nest on the ground in the woods. Shortly after hatching, the baby grouse follow their mother, who leads them through the woods in search of food. During the night the hen broods them.

RUFFED GROUSE—DRUMMING BIRDS

The Ruffed Grouse, *Bonasa umbellus,* is the best-known New World species, and has often been called the "king of upland game birds." Extensive hunting since Indian times has made it a shrewd and wily bird. It springs into the air with a startling whirr of its powerful wings and dodges away swiftly among the trees.

The male ruffed grouse is famous for his habit of selecting a log in the woods, strutting along the log with his tail widely spread and the black ruff on his neck fully expanded. From time to time, with wings whirring so rapidly that they are almost invisible, he produces a muffled drumming to attract a mate. Slow-motion movies have shown that the whirring wings do not strike anything; the drumming sound is produced by the vibrations set up in the air.

The ruffed grouse is about fifteen inches long. Its handsomely and intricately mottled plumage matches the colors and shadows of the brush or woodlands where it lives. In some birds the tail is gray, in others chestnut. This variation has nothing to do with sex or age. When winter comes on, the ruffed grouse grows fringes of hairlike bristles along the toes. These serve the function of snowshoes. Sometimes the bird plunges from the air into a soft snow bank to spend the night. This has the advantage of leaving no telltale tracks to guide its enemies. It feeds on berries, fruit, buds, or even hemlock needles.

Every ten years or so the population of the ruffed grouse drops to a very low level. Naturalists conjecture that these cycles are produced by disease; but, despite a great deal of research, we do not know the exact cause.

PLAINS GROUSE AND THEIR WEIRD BOOMING

The Prairie Chicken or Pinnated Grouse, *Tympanuchus cupido,* and **the Prairie Sharp-tailed Grouse,** *Pedioecetes phasianellus,* are two rather similar species, found on the Great Plains of North America wherever they have not been driven out by hunters or the advance of farming. The sharp-tail has suffered less; it is more partial to brushy or sandy wastelands.

In the spring, male prairie chickens gather on communal dancing grounds and utter weird booming sounds. They produce the noise by

first distending bright-colored air sacs on the side of the neck and then expelling air from them. As they boom they spread the tail and extend the pointed feathers (*pinnae*) on the neck. Each performer has his own little bailiwick which he defends vigorously against other cock grouse. When the hens approach, each of the males outdoes himself in courtship display.

In bygone times there was an eastern race of the prairie chicken in the pine barrens and semiopen country of the northeastern states, including Long Island, New York. Known as the Heath Hen, it quickly succumbed to hunters—except on the island of Martha's Vineyard off the Massachusetts coast. Even there it eventually died out—a victim of disease and brush fires.

The Sage Hen, *Centrocercus urophasianus,* the largest American grouse, makes its home in the sagebrush country of the Great Basin. This large area, which has no Pacific coast drainage, includes parts of California, Oregon, Idaho, Nevada, and Utah. The cock sage grouse is much larger than the hen. Early in the morning, and sometimes in the evening as well, the males gather on display grounds at mating time and strut around. Letting their wings droop, they spread their tails wide and inflate their yellow throat-sacs. To impress the hens still more, they produce curious sounds as they expel the air from their sacs.

Though the sage grouse is not very tasty, it has been greatly reduced in numbers because it presents an easy target that hunters cannot resist.

SPRUCE GROUSE—"FOOL HENS"

The Spruce Grouse, *Canachites canadensis,* dwells in the gloomy spruce forests of Canada and northern United States. Living in the wild where it seldom sees man, the spruce grouse is very unsuspecting. Hunters sometimes call this small grouse "fool hen" because of the ease with which they can shoot down one bird after another without alarming the rest of the flock.

The male spruce grouse has a varied pattern of black and white, with a scarlet wattle over the eye adding a touch of brilliant color; the female is brownish. Usually tasting of spruce needles, the flesh of this grouse has no attraction for epicures.

PTARMIGAN—GROUSE OF THE ARCTIC REGION

The most northern-dwelling members of the grouse family are ptarmigan. In both hemispheres we find the Willow Ptarmigan, *Lagopus lagopus,* and the Rock Ptarmigan, *Lagopus mutus,* in the Far North—even on the island of Spitsbergen where, during midwinter, the sun never appears above the bleak horizon.

Ptarmigans' summertime plumage is black, brown, and white, but with the approach of winter they molt into a snow-white garb. This change of costume makes them less noticeable as they search the snowy landscape for seeds or buds. Their legs and feet are fully feathered to endure the cold, and they burrow beneath the snow for shelter as well as for food. The ptarmigan is a valued source of food for the Eskimos.

Much further south we find a third species in the Rockies—the White-tailed Ptarmigan, *Lagopus leucurus,* which ranges southward at high altitudes as far as Colorado.

A curious feature of the Red Grouse, *Lagopus scoticus,* which makes its home on the heather-covered moors of the British Isles, is that although it is a ptarmigan, its plumage does not turn white in winter. Sportsmen journey to Scotland from all parts of the world to go grouse-shooting.

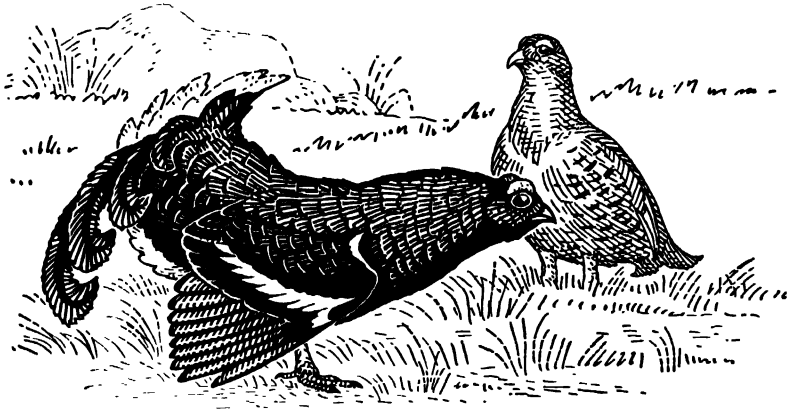
OLD WORLD GROUSE AND THEIR COURTSHIP HABITS

The Capercaillie, *Tetrao urogallus,* is the largest of the grouse—almost as big as a turkey. As we can gather from its common name, "cock of the woods," it is partial to forest areas. A Eurasian bird, the capercaillie was exterminated in Britain, and reintroduced there later.

When displaying at courtship time, the glossy black male stretches out his neck and raises and spreads his tail as he utters a peculiar cry. In former times, large numbers of capercaillie were shot for the table while thus absorbed in courtship; nowadays this unsportsmanlike practice is prohibited.

The European Black Grouse, *Lyrurus tetrix,* is related to the capercaillie, though a much smaller bird. The cock's long outer tail feathers are twisted and their shape resembles a lyre—hence the name

Lyrurus. Like some American grouse, the black grouse males gather on a communal display ground. Raising the lyrate tail above his back, the cock displays the snow-white coverts or feathers beneath the tail. The sportsman calls this species "blackgame."



A EUROPEAN GROUSE

The male black grouse is noted for its twisted, lyre-shaped tail feathers. Like its American cousins, this bird engages in displays on communal mating grounds.

Cranes, Rails, and Their Relatives

THERE IS a vast difference in size and appearance between the long-legged cranes, standing five feet or so in height, and the tiny button quail and small rails. The birds in this order (the Gruiformes) are among the most ancient ones we know, making up nine living and some fossil families. Among the still existent families we find several that contain no more than a species or two and seem to be declining or relict groups approaching extinction. The rails are the largest and most flourishing family of the order; however, the

cranes, bustards, and button quails are well represented in certain areas. Many of the gruiform (cranelike) birds live in marshes or swamps—others, the bustards, for example, dwell on dry plains. Birds of this order usually lay mottled brown or olive eggs; the young are covered with down and generally leave the nest shortly after hatching.

MESITES—FLIGHTLESS RELICS

Madagascar is the only place where we find the three species of mesites. They are undoubtedly relics of some primitive group of rail-like birds that found asylum on this island many ages ago. The habits of one of them, Bensch's "Rail," *Monias benschi,* were studied by A. L. Rand. He found that it is apparently incapable of flight and lives on the ground in sandy, brushy areas. It feeds on fruit and insects. The open nest is placed in a thick bush that the bird can ascend by walking or hopping. What evidence we have indicates that the male does most or all of the incubating.

Bensch's "rail" is a sandy, grayish bird, spotted on the breast and with dark stripes on the face; indeed, it looks not unlike some of the desert thrashers (Mimidae) of southwestern United States. Mesites are grouped in the family Mesoenatidae.

CRANES—TALL AND LONG-LEGGED BIRDS

It is no accident that one of the members of the crane family is the tallest bird in North America. The cranes are exceptionally tall, very large birds with long legs and neck. Usually they stalk around in marshes or on plains, feeding on insects, amphibians, and even small mammals, as well as grain and grass shoots. The hen lays two eggs, mottled with olive and brown.

Although there are fourteen species in the crane family, the Gruidae, we find none of them in South America. However, they dwell in most other parts of the world, and two are native to North America. Most of the northern species of cranes are noted for the sonorous, sorrowful cries they utter as they wing their way southward on migrations. The trachea (windpipe) is extra long in cranes, and part of it is coiled within a hollow in the breastbone. It is this arrangement that imparts such resonance and volume to the crane's distinctive call notes.

NEW WORLD CRANES

The Whooping Crane, *Grus americana,* the tallest bird in North America, is also one of the most graceful. Sad to say, this bird is reduced to the verge of extinction, with barely thirty survivors. This remnant winters on the Aransas refuge in southern Texas and nests somewhere in the Arctic. Although every effort is being made to preserve the stately white bird, it has barely maintained its pitiful numbers during the past few years. Wary though this crane is, its conspicuous plumage makes it vulnerable to high-powered rifles in the hands of irresponsible gunners.

In former times, when the whooping crane was plentiful, it nested in the central part of the continent south to Iowa or possibly as far as Louisiana; it appeared even on the Atlantic seaboard when migrating.

The Sand-hill Crane, *Grus mexicanus,* the other American species, has a loud deep croak that carries quite a distance. A wary bird, it is a brave fighter when cornered, its long bill making an effective weapon. This crane is brown and slightly smaller than the whooping crane. Though greatly reduced in numbers, the sand-hill crane still nests from Michigan to eastern Oregon and north into Canada. Another variety of the same species breeds in the Arctic, a third in Florida and Mississippi, and a fourth in Cuba. Fortunately all the races of this species, aside from the Cuban one, are holding their own.

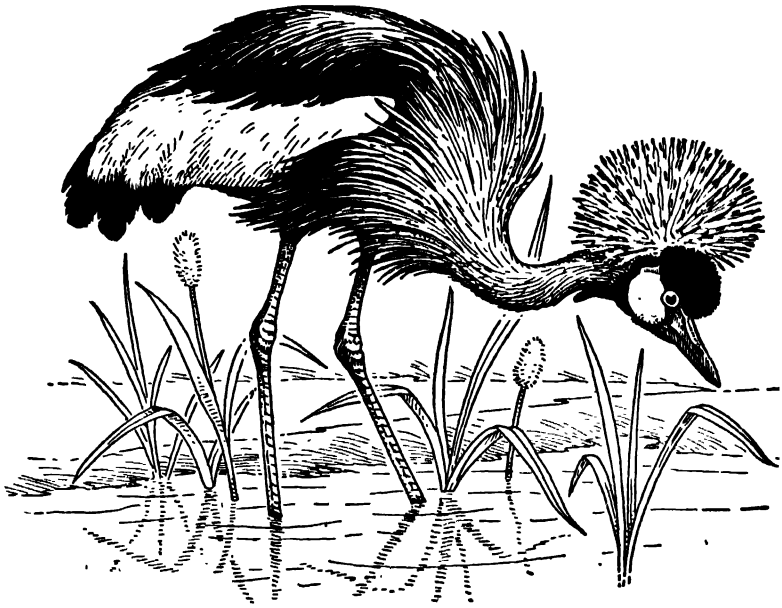
As we saw earlier, the Great Blue Heron is often mistaken for a crane. However, they belong, as we know, to quite different families.

OLD WORLD CRANES

The Common Crane, *Grus grus,* nests in the northern parts of Eurasia. Its migrations through the Mediterranean area were described by the ancients. In several Old World cranes the feathers of the back have become lengthened into ornamental plumes. This is particularly true of the Demoiselle Crane, *Grus vipio.* Like other cranes, it dances about on the tips of its toes, flaps its wings, and bobs its head in a most comical manner when courting.

The African Crowned Crane, *Balaerica pavonina,* with its dense crest of erect golden plumes and scarlet cheek patches, is perhaps the

most beautiful of all the cranes. The Australian Crane, *Grus rubricunda*, a large grayish species, is quaintly known as the "Native Companion," because the Australian bushmen often have a tame one around camp.



A HANDSOME BIRD—THE CROWNED CRANE

The African crowned crane is considered by many the most beautiful of this family of tall, graceful birds. It has a thick crest of erect golden plumes, and vivid scarlet patches on its cheeks. Its New World cousin, the whooping crane, is the tallest bird in North America.

LIMPKINS—"CRYING BIRDS"

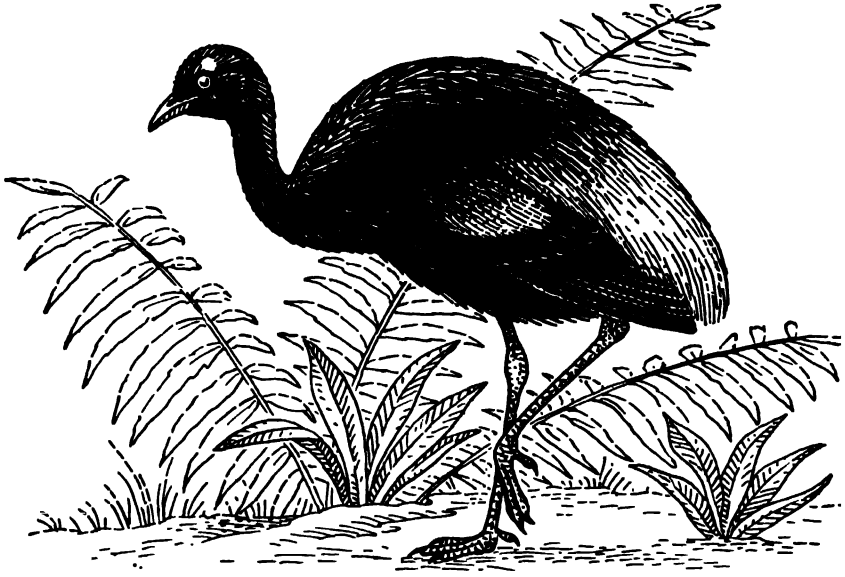
The Limpkin, *Aramus scolopaceus,* has a prolonged wailing cry that is poignant and disturbing—hence the nickname "Crying Bird." A shy bird, it prefers hiding to flying. Unlike the cranes, to which it is related, it perches readily in bushes, trees, or reeds. It builds its nest in a bush a few feet above one of the extensive marshes where it makes its home through the tropical parts of America north to the West Indies and Florida. About the size of a chicken, it has long legs and a long curved bill. Its plumage is olive brown, streaked with white. The limpkin feeds on snails and other water-dwelling creatures. Aramidae is the scientific name for the limpkin family.

TRUMPETERS—MUSICIANS OF THE JUNGLE

The Common Trumpeter, *Psophia crepitans,* dwells in tropical South America. Trumpeters have a certain resemblance to a domestic guinea hen, but the neck and head are more cranelike.

The common trumpeter's chief claims to fame are its trumpet-like calls and deep, resonant notes. We once kept a male captive for several days, and although we observed him carefully and closely as he delivered his rumbling call, we never did come to a definite conclusion about the source of the notes. The richly vibrating sound seemed to spring from the very depths of the body in a rather ventriloquistic manner. Trumpeters—there are three species of them, making up the family Psophiidae—roost in trees at night and produce the eeriest of growling notes when disturbed. Instead of nesting in the trees, however, they place their nests on the ground. The hen lays up to ten green eggs.

The common trumpeter is blackish with long, bright-green legs and



MUSICAL BIRD OF SOUTH AMERICA

The trumpeter utters clear, rich, trumpet-like and deep, ventriloquistic notes. Just how it is able to produce the deep notes is still something of a mystery to naturalists. A group of these birds can make quite a din—not always a prudent course in the jungle. Domesticated, the trumpeter doubles as a delightful pet and an efficient "watchdog."

a short green bill. Its tail is stumpy and soft, and the feathers about the neck are short and velvety with deep, iridescent, purplish reflections. The brilliant effect is enhanced by the vivid tan banding on the lower back and wing feathers; the inner flight feathers are elongated and grayish.

This bird feeds in large flocks on fallen fruit gathered in the depths of the tropical forest. When an intruder happens to come upon such a flock, the trumpeters fly noisily into low perches nearby and gawk at him. If he is a hunter he will have no trouble wiping out most of the group. Since trumpeters are very tasty eating, they soon become scarce or disappear altogether when man makes his appearance.

In Brazil, however, the trumpeter is often domesticated and allowed to associate with barnyard fowl. It is reported to make an excellent "watchdog," calling noisily at the first sign of danger at night. Though the trumpeter is a friendly, charming pet, it apparently will not breed away from its home grounds.

BUSTARDS—AMONG THE HEAVIEST OF FLYING BIRDS

There are some twenty-three species of bustards, all of them Old World birds. They are medium sized to large, related to the cranes, but with shorter legs and heavier bodies. Bustards are partial to dry plains and run swiftly. On the steppes of Asia they are often hunted on horseback. Some of the larger bustards weigh thirty pounds or more, and are among the heaviest of flying birds.

Bustards have an exceptionally varied diet, eating seeds, green shoots, insects, small reptiles, and even mice or birds. Their flesh is considered a delicacy. They lay two to four protectively colored eggs in a shallow, unlined depression on the ground. Africa is the stronghold of this family (the Otididae), but several species are native to Asia and one to Australia.

The Great Bustard, *Otis tarda,* was killed off in Britain as early as 1838. However, it is still found in Poland and elsewhere in eastern Europe and parts of Asia. The great bustard's over-all color is gray, with black wing quills. It has long white bristles at the base of the bill, while other kinds of bustards are ornamented with a variety of bristles or plumes, which they display in the courtship postures or dances. The male has a gular (throat) pouch of thin skin. At pairing time he struts around with the throat pouch inflated, head thrown

back against the shoulders, tail erect and spread and wings drooping. Very quarrelsome at this season, the males utter threatening booming sounds, probably produced by the sudden expulsion of air from the throat.

SUN BITTERNS AND THEIR EXTRAORDINARY DANCE

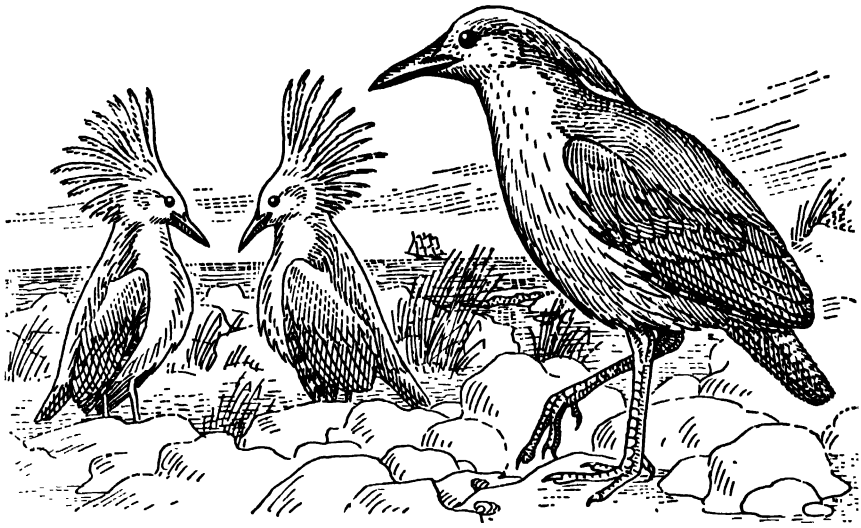
The Sun Bittern, *Eurypyga helias,* is found only in the tropical parts of the New World. It is related not to the bittern, as we might expect, but to the crane tribe, and makes up a family by itself, the Eurypygidae. The sun bittern is remarkable for a dance performance that is quite out of the ordinary, as it spreads its wings and tail in a nearly horizontal horseshoe which, umbrella-like, completely hides its body. The wings of this bird have broad maroon centers, black, gray, and white tips, and broad, yellowish olive bases. The amazing dance displays this brilliant wing pattern to best advantage.

The sun bittern has a slender neck and head, the latter being black with a white stripe under the eye. The throat and abdomen are white, the upper parts gray barred with black. Together with the wing pattern already described, this adds up to a very striking color scheme.

Sun bitterns feed on insects and small fish. They place the nest of sticks, grass, and mud in a tree in flooded river-bottom forest. The eggs are reddish buff with black markings.

KAGUS—FLIGHTLESS BIRDS OF NEW CALEDONIA

The Kagu, *Rhynochetos jubatus,* dwells only on the large island of New Caledonia, some thousand miles east of Australia. This bird, which figures on the postage stamps of New Caledonia, is about the size of a chicken and is the sole member of the family Rhynochetidae. It has gray plumage, to which the orange-red of its feet is a vivid contrast. The wing quills are boldly barred with white, and the kagu displays them at courting time in much the same remarkable manner as the distantly related sun bittern of tropical America. Barely able to fly, the kagu is active chiefly at night. Formerly there were no predatory mammals on New Caledonia; but now that cats, dogs, pigs, and rats have been introduced and much of the forest cut off, this strange bird faces extinction.



STRANGE BIRD OF THE SOUTH SEAS

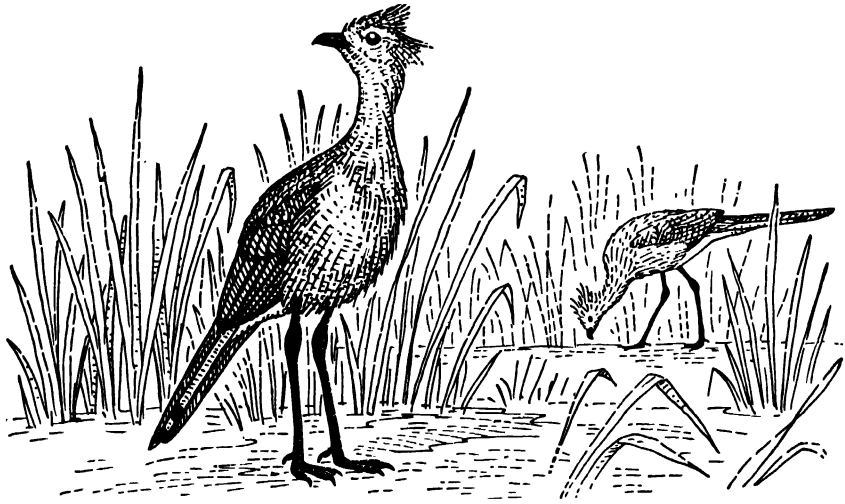
An ancient, almost flightless bird, the kagu lives only on the Pacific island of New Caledonia. Noted for its remarkable courtship dance displays, the kagu is mainly active at night, and feeds on worms and slugs; by day it hides among rocks or the roots of trees. Kagus engage in amusing antics and often erect their tall crests.

CARIAMAS—ANCIENT AND DIGNIFIED

The cariama is still another of the ancient types of cranelike birds. There are two species, both natives of South America and members of the family Cariamidae; both are stately, long-legged birds with long tails and a bustard-like mane of hairy feathers growing from the crown and neck. They are notable for their erect posture and their preference for spending most of their time on the ground. These qualities remind us of the secretary bird of Africa—though naturalists usually consider that bird to be more closely related to the eagles than to cariamas or cranes.

The Gray Cariama, *Chunga burmeisteri,* dwells in northern Argentina. Including its tail, the bird is about three feet long. Above, it is smoky brown sprinkled delicately with buff and becoming gray with profuse black bars on the head and mane. There is white around the eye and on the abdomen. The throat, neck, and chest are colored like the head but with finer black barring. The wings and tail have heavy gray and white bars.

We find cariamas in grassy semiwooded regions, sometimes in flocks, more frequently in pairs. The nest, constructed of twigs, is placed on the ground or in a bush or low tree. The cariama lays two pale eggs with brown markings. We are told that the cariama's call resembles a dog's bark!



THE CARIAMA PREFERS TO STAY ON THE GROUND

A stately, long-legged bird which spends most of its time on the ground, the cariama, of South America, has a long tail and a mane of hairy feathers. Berries and insects are prominent on the cariama's menu, but it will also eat snakes and lizards.

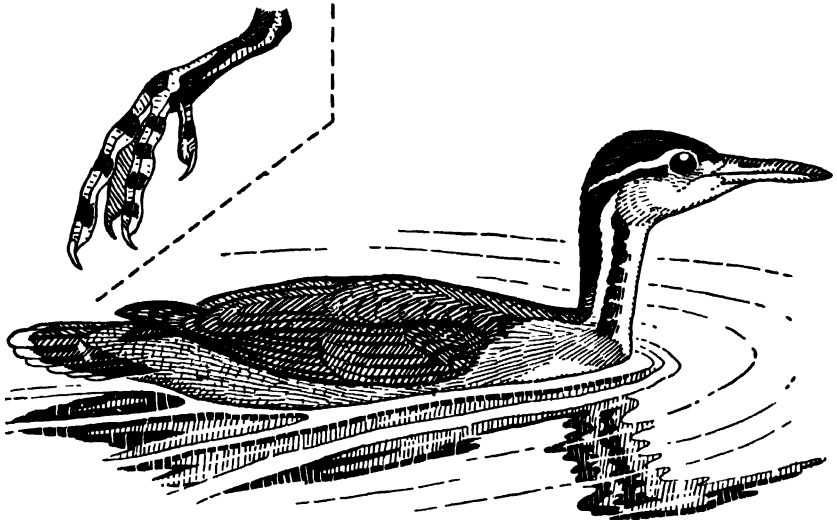
THE DIATRYMA—FANTASTIC FOSSIL

There is a possibility that the giant fossil running birds discovered in the Eocene rocks of North America may be related to the cariama. These primitive birds must have been extraordinary creatures, judging from the largest and only complete example, *Diatryma steini*, now on exhibit in the American Museum of Natural History in New York City. Standing more than six feet tall, the relic is equipped with a tremendous skull and a bill of the general shape of a meat cleaver, though somewhat larger.

FINFEET—SKILLFUL SWIMMERS, SLUGGISH FLIERS

Finfeet are curious grebelike water birds of tropical South America, Africa, and Asia. They have the bill of a rail, lobed feet, short legs,

elongated bodies, and long, pointed wings. There are only three species, all of them belonging to the family Heliornithidae. Very secretive birds, they take to the water to hide. They dwell in swamps and wooded streams, building a crude nest in a mass of vegetation a few feet above the water. Though finfeet run, swim, and dive with great ease, they are heavy and sluggish when it comes to flying. They sprint furiously with the lobed feet in taking flight.



THE FINFOOT—STRANGE BIRD OF THE TROPICS

The finfoot (or sun grebe) is a strange tropical bird with fascinating ways. Thoroughly at home in the water, it does not care much for flying. This bird lives along sluggish streams and dives as skillfully as the true grebes. It places its nest in tangled vegetation a few feet above the water. The New World finfoot, above, has lobed, banded feet, as shown.

The New World Finfoot, *Heliornis fulica,* is dull olive with a blackish head, neck, and tail. White stripes decorate the sides of the head and neck. The bill is reddish and the feet are curiously banded with black and yellow.

BUTTON QUAILS—DRUDGERY IS FOR MALES

All sixteen species of the button quails live in the warmer regions of the Old World. Ranging from five to seven inches long, they look like miniature quails. In every case the female is larger and more brilliantly colored than the male. She flouts tradition in other ways as well, for it is she who attracts a mate by booming courtship calls,

and it is the male who shoulders the duties of incubation and bringing up the young. After the female has laid a clutch of eggs and left them for her mate to incubate, she is believed to repeat this procedure with a second mate.

The nest, located in a grassy depression in the ground, is sometimes domed with grass. A clutch consists of three to five cone-shaped, spotted eggs. Covered with down when they hatch, the young are able to run as soon as they leave the shell. Button quails feed on insect larvae, berries, and seeds. These ground-dwelling birds, also known as hemipodes or bustard-quails, are related to the rails, and compose the family Turnicidae.

When we observed button quails in the Philippines and New Guinea, they confirmed their reputation for being exceedingly shy and often difficult to flush from the tall grass where they live. They run strongly, but when sufficiently startled they flutter for short distances over the grass and then drop abruptly into it.

The Collared Hemipode, *Pedionomus,* of Australia, differs from the other members of the Turnicidae in several ways and is often placed in a separate family.

RAILS, COOTS, AND GALLINULES

The 132 species of this worldwide family are running birds with long legs and toes and a slender body for slipping through dense vegetation—so slender, indeed, as to give rise to the phrase, "thin as a rail." Most of them live in marshes or swamps, though many tropical rails dwell in forest areas. As for the lobe-toed coots, they swim and dive as expertly as ducks. Rails usually have a mottled or spotted plumage pattern of brown, yellow, chestnut or other modest colors. However, some of the gallinules and swamp hens are bright purple.

Most rails have a varied repertoire of loud notes—sometimes eerie whistles, other times henlike cackles. Often their voices have a ventriloquial quality that deceives a listener if he tries to locate the birds. Many years ago an unknown bird, dubbed "the kicker" because its call sounded like *kick-kick-kick,* was heard in marshes along the Concord River in Massachusetts by a goodly number of expert bird-students. All efforts to get a glimpse of the bird failed, but it was probably the Black Rail, one of the sparrow-sized and characteristically shy members of the family.

Rails are excellent game birds—they are delicious eating and, despite their mediocre flying abilities, are exceptionally elusive. The approved hunting technique is to pole about the marshes at high tide. This forces the Sora and Clapper Rails to fly rather than to run when approached by a boat. Then they offer the gunner a good target.

Rails, as you have gathered, are very secretive, running through the dense grass with great swiftness when disturbed and resorting to flight only when they have no choice. Though they have small wings, many of them make lengthy migrations at night, and the family is well represented on remote islands in all parts of the world. Several of the island species have completely lost the power of flying.

The members of this family, known as the Rallidae, feed on insects, tubers, seeds, worms, water plants, mollusks, and occasionally lizards and mice. Here are some typical American representatives of the family:

The Clapper Rail, *Rallus longirostris,* which makes its home in salt marshes, is a brown bird half the size of a chicken. It has an unfortunate habit of flying low on migrations, and is therefore prone to flying accidents. Like many rails, it engages in dances, performed to the accompaniment of a crescendo of screeching notes. The clapper rail fashions its nest of grasses and places it on the ground in salt marshes. The young—and this is true of most rails—are black and very precocious, being able to swim and run almost as soon as they are hatched.

The Purple Gallinule, *Porphyrula martinica,* is a brightly colored species which dwells in the warmer parts of the New World. About eleven inches long, it swims well and favors ponds choked with water plants. It flies more readily than most rails and is easily identified on the wing. A crimson bill, bluish forehead shield, and conspicuous under-tail quills set off its purple plumage. The purple gallinule's nest is a platform of reeds in cane grass and rushes. The four to ten eggs are white with reddish markings.

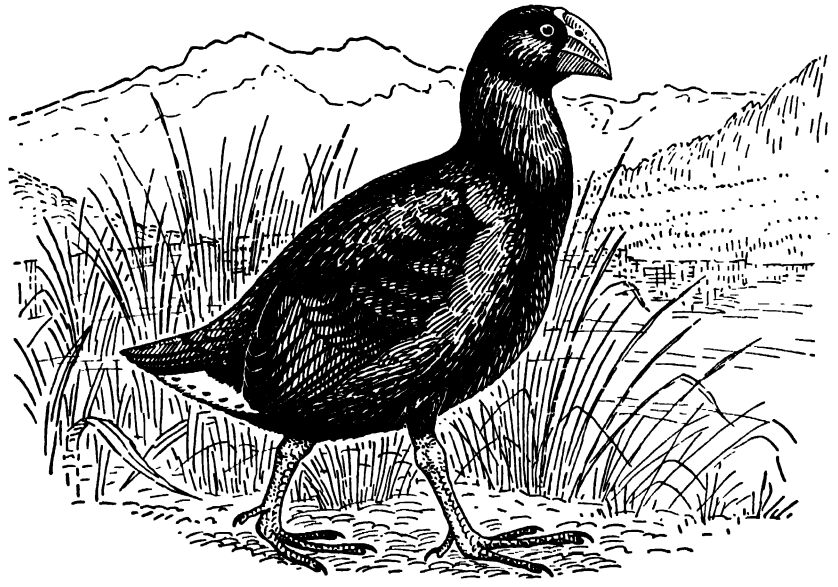
The American Coot, *Fulica americana,* ranges from Alaska to Ecuador. About the same size as the clapper rail, it has longer wings and sometimes flies in great flocks. It feeds mostly on vegetable matter. Related species dwell on the other continents. They are all slaty-gray birds, usually with a conspicuous, white, chicken-like bill.

SOME OTHER RAILS AND THEIR ELUSIVE WAYS

As we have seen, rails are fond of wet terrain. Still, some species, such as the Wood Rail, *Rallina eurizonoides,* live on the floor of deep tropical jungle that is relatively dry. Others—the large, sooty-gray Grass Rail, *Rallus torquatus,* for example—often visit fields some distance away from water. This makes it difficult for us to generalize about where rails prefer to live.

Many kinds of rails live on tiny, bleak, sometimes arid islands far out on the ocean. The flightless Wake Island Rail, *Rallus wakensis,* had only one reasonably permanent source of drinking water: the tiny caches of rain water that collect in mollusk shells! Other kinds of rails live out their lives within hailing distance of their birthplace. This is forcibly brought home to us by the Iceland Rail, *Rallus aquaticus,* which dwells in tiny oases surrounding hot springs.

Then there are rails so strongly concentrated in a local area that they become "lost." Take, for example, the large flightless rail, *No-*



NOTORNIS—LOST AND FOUND

Flightless birds concentrated in a remote area can easily become "lost" to science. That is what happened to *Notornis,* a member of the rail family. From 1900 on, it was considered extinct. Yet half a century later naturalists discovered this bird dwelling on the shores of a mountain lake in New Zealand.

tornis hochstetteri, which in 1949 was discovered in some numbers in New Zealand living along the shores of an alpine lake. Yet the experts had considered the bird extinct for half a century! Other kinds of rails, which are known to us from only a few individuals, are really very common. We had an instance of this kind in the case of the Schomburgk Rail, *Micropygia schomburgkii,* a starling-sized brown and yellow denizen of the highland grass fields lying between the Amazon and Orinoco Rivers. One day in 1938 our Indians started a grass fire and casually trapped more than twenty of these birds. Before that, hundreds of hours of hunting in the same fields, both by natives and white men, had yielded only a single example of this "rare" bird.

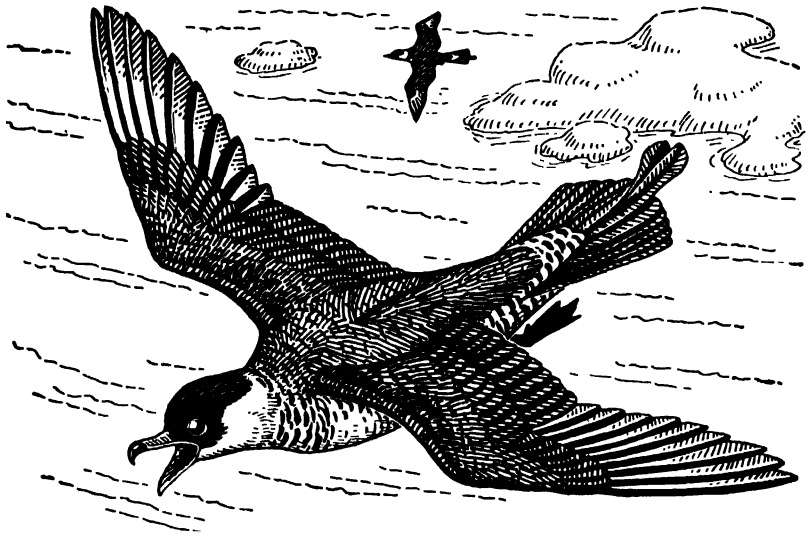
Shore Birds, Gulls, and Their Relatives

Most of the birds grouped in this order, such as the sandpipers, plovers, and gulls, live on the water or near it; a few dwell on arid plains. Naturalists divide the shore birds proper into ten families—the best known are the sandpipers and the plovers. Most shore birds have long legs—their feet are not webbed—and are swift runners. The bill is adapted for picking small insects and other food from mud or shallow water. These birds almost invariably place their eggs on the ground. The young are cute little balls of down; they run after their parents almost as soon as they are hatched. Among several families of shore birds we note a trend toward reversing the usual nesting behavior of birds. Among these families the female is more brightly colored and assumes the initiative in courtship; so we are not so surprised to learn that it is the male who incubates the eggs and cares for the young.

The pratincoles, a group of Old World shore birds, are

long-winged, short-legged birds which feed on insects they catch on the wing as swallows do. We may think of them as forming something of a transition to the other main division of this order—the gulls and terns. These birds, unlike the shore birds, have webbed feet. They live near salt or fresh water. The young, though born with down, are less active than those of shore birds and usually linger near the nest for some time after hatching.

The relatives of the gulls include the jaegers and the skuas—aggressive and almost hawklike, they often catch and eat small birds and mammals. The strange lily-trotters or jaçanas—birds with unusually long toes adapted for running over water plants—present a problem to naturalists. Usually the experts place them with the shore birds, though there is a theory in some quarters that the lily-trotters may



THE POMARINE JAEGER—ARCTIC HUNTER

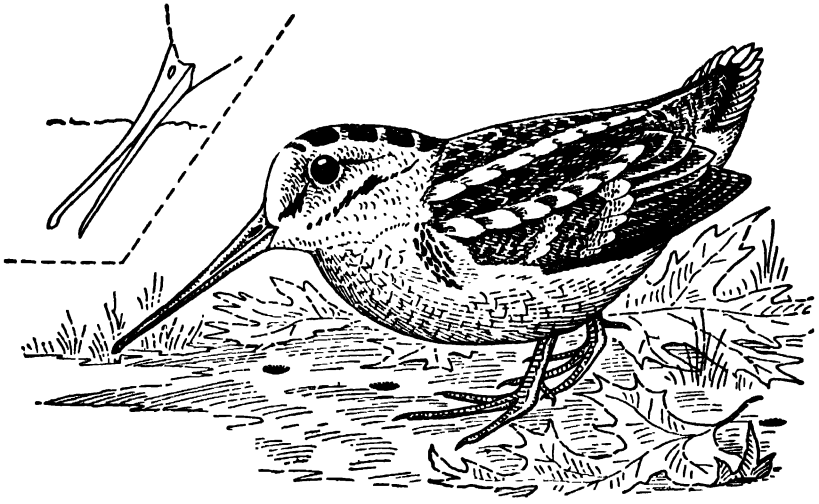
The German word for "hunter" is *Jaeger*—an appropriate name for this large gray and black marauder which hunts for lemmings and small birds on its Arctic nesting grounds. It spends the winter at sea in latitudes as far south as central Africa and even Australia. The jaeger keeps well offshore and we rarely see it in the United States.

be more closely related to the rails. The auks and puffins are also believed to be related to the shore birds and gulls. The birds described in this chapter make up the order Charadriiformes.

SANDPIPERS—BIRDS OF THE SEASHORE

You can readily see how the sandpiper got its name—it lives, with a few exceptions, on sandy beaches and has a piping cry. The sandpiper family (the Scolopacidae), with seventy-seven species, is the largest group of shore birds. Most members of the family breed in the Far North and winter along southern seashores. Their long legs are useful when it comes to wading in mud or shallow water. Still another adaptation for life on the beach is their long bill, which they use to pick small crabs or insects from the ground or mud. Despite the absence of bright colors, shore birds are attractive, alert birds, with varied plumage of brown, gray, white, or chestnut. They place the four rather large, pointed eggs in the nest with the small ends together. In this way the eggs form a circle that the incubating bird is just able to cover. The nest is not an impressive affair—a mere depression in the grass or sand, sometimes sparingly lined with grass.

The Woodcock, *Philohela minor.* This is the New World species of one of the few sandpipers that do not visit the shore. It is a plump, big-headed, brown bird, about twelve inches long. Its unusual appear-



THE WOODCOCK—POPULAR GAME BIRD

Nicknamed the "timber-doodle," the woodcock has a long probing bill which enables it to drill for earthworms far below the surface of the mud. The tip of the beak is flexible, and can be opened underground to seize the prey. Even while intent on its meal, the woodcock can see approaching enemies, for its eyes are placed high on its head.

ance has won for it such names as "Timber-doodle." It does much of its feeding by probing with its long bill in mud for earthworms. The woodcock can open the soft, sensitive tips of this bill to seize a worm far below the surface of the mud. You might think that the bird is in an exceedingly vulnerable position when its bill is buried deep in the mud; but the woodcock's eyes are placed rather high on its head, enabling it to see an approaching enemy.

During the spring, woodcocks assemble on courtship grounds. The male utters sharp *peent*-like notes and then rises high in the air and circles about. He descends in a series of dives, meanwhile delivering beautiful twittering notes. While we do not know for certain, there is some reason to believe that this music is produced by the air rushing through the narrow, stiff outer wing feathers, rather than by the vocal cords. The woodcock is one of the most popular game birds.

The Jacksnipe or Wilson Snipe, *Gallinago delicata,* was given its scientific name because it is a table delicacy. Less than twelve inches long, it is related to the woodcock, and performs in much the same way during courtship. The snipe's notes, which have a bleating quality, are produced by the air rushing through the stiffened outer tail feathers. In the case of the Pintail Snipe of the Old World, we find that all of its tail feathers are almost as stiff and slender as toothpicks.

While the woodcock prefers alder bogs, the snipe frequents open marshes or wet meadows. Both have rather solitary habits and are distributed throughout the United States. Consequently they have not been so seriously reduced by hunting as the other American shore birds, and are still on the list of game birds. All sandpipers are strong fliers, the snipe especially so, which makes it a very difficult target for the sportsman.

The Spotted Sandpiper, *Actitis macularia,* is a small bird—about eight inches long. To the country boy it is the "Tip-up" because of its habit of teetering back and forth as it sits nervously on a sand bar or log. The spotted sandpiper can run rapidly when necessary. Found almost throughout the length and breadth of North America, it is most common near water, though it will occasionally live in dry fields. The newly hatched young, like all baby sandpipers, are covered with soft down. Their colors blend perfectly with their surroundings. Before migrating south in the fall, the spotted sandpiper loses its spots and becomes plain white below. We observe this molt into a simpler winter dress among most sandpipers.

The many kinds of sandpipers that are at home at the seashore range in size all the way from the tiny Least Sandpiper, a bird scarcely larger than a sparrow, to the curlews and godwits, which stand about a foot tall. Most sandpipers nest in the Arctic. In the spring they are among the last migrants to go north, lingering in large numbers until late May. When it comes to journeying south in the fall, they are among the first birds to leave, appearing in some numbers on the coasts of the United States as early as July.

Though many sandpipers visit the coasts of the Southern Hemisphere, it is quite unusual for any of them to nest in tropical or southern latitudes. One exception is the little Polynesian Sandpiper, *Aechmorhynchus,* found on the tiny coral islands of the Tuamotu chain near Pitcairn Island in the Pacific. The chances are that it is descended from wandering migrants of some northern species.

As we have seen, many sandpipers breed in the remote north, which has made it difficult for naturalists to study their nesting habits. It took until 1948 to find the nest of the Bristle-thighed Curlew, *Numenius tahitiensis,* an American species that nests on a bleak stretch of tundra in Alaska. When it feels the approach of the arctic cold, this curlew flies more than two thousand miles to Hawaii and other nearby islands to spend the winter. It was one of Captain Cook's famous expeditions that discovered the bristle-thighed curlew on Tahiti, and named it *tahitiensis.*

PLOVERS—EXTRAORDINARY MIGRATORS

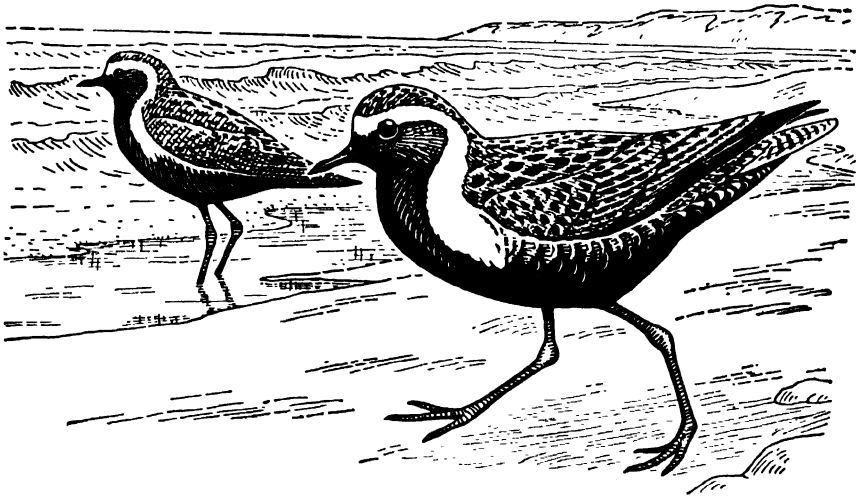
To Europeans the plover is the "rain bird" because of its habit of scolding before rain. ("Plover" is derived from *pluvia,* the Latin word for "rain.") We find the sixty-three species of this family—plovers, turnstones, and surfbirds—in almost all parts of the world. A good many of these birds are famous for their remarkable migratory journeys. Closely related to the sandpipers, the members of the plover family (the Charadriidae) have shorter legs and a shorter bill.

For the most part, plovers are small or medium-sized birds with coloring that runs to quiet hues. They are equally at home on coasts, plains, or fields. All have a relatively large head and a body that is plump because of the highly developed flying muscles. These plump birds are good to eat. In plovers the hind toe is either lacking or very small.

Almost without exception, plovers lay four relatively large eggs

in slight depressions in sand or earth. These eggs are cone-shaped and speckled or blotched with brown and black. In Europe, plovers' eggs are eaten a good deal.

The Golden Plover, *Pluvialis dominica,* is one of the most outstanding of all migrating birds. About eleven inches long and with a wing spread of some twenty-three inches, it is a good-looking bird, mainly black with golden yellow flecking on the back when it is in breeding plumage. It nests during the short Arctic summer on the tundras of the Far North. With the coming of warmer weather, the snow on these wastes has melted faster than the ground can absorb it, leaving vast marshes that abound in mosquitoes and gnats. The plover snaps these up as well as other insects and worms.



A FAMOUS MIGRATORY BIRD

The golden plover nests on the Alaskan tundra in summertime, and with the approach of cold weather makes a nonstop flight of twenty-four hundred miles to Hawaii. In late spring it returns to Alaska. The Atlantic variety of this bird makes a similar nonstop flight from Nova Scotia to South America.

In September, as they sense the long Arctic night coming on, the plovers leave on their nonstop migratory flights. The Pacific birds travel some twenty-four hundred miles, nonstop, from Alaska to Hawaii. Unable to swim well, they make the trip without food or drink or rest, at a speed variously estimated from forty to seventy miles an hour. Thousands take part in this migration, and by April or May they are on their way back to the Far North.

Their Atlantic cousins make a slightly longer nonstop flight from Nova Scotia to the coast of South America, winding up by wintering on the pampas. In the spring these plovers return by a totally different route, navigating north along the coast of South and Central America and then up the Mississippi valley. Yet they return, miraculously, to their ancestral breeding grounds—to nest sometimes at precisely the same spot as before. Old World plovers are noted for similar migrations between the northern latitudes and islands in the Indian Ocean as well as Australia and New Zealand.

The Killdeer Plover, *Charadrius vociferus,* gets its curious name from its frantic cry of "Kill-dee." This call is as familiar to farm boys as its broken-wing ruse—a device used by all plovers to draw interlopers away from their nest. After the spotted sandpiper, the killdeer is probably the most common of American "shore birds." It may winter or migrate along the shore, but when the nesting season arrives, the killdeer will spend much of its time on gravelly, sandy, or grassy fields, sometimes close to human habitations. We have found the killdeer nesting, for example, on lawns and football fields. Some ten inches long, the killdeer is a tawny-rumped bird with brown upper parts, white under parts, and two black bands across the breast.

The Ruddy Turnstone, *Arenaria interpres,* about nine inches long, is another remarkable migrator. Nesting in the Arctic regions, it travels in the fall to southern Brazil and Chile and sometimes even as far as the Antarctic! You are probably curious about its name, which comes from its unusual eating habits. With its strong bill, this bird turns over stones, shells, and pebbles in search of small crustaceans, slugs, and worms. It also feasts on grasshoppers. A link between the plover and sandpipers, this handsome bird is brilliant reddish brown above, white below, with black markings on the face, chest, wings, and tail.

OTHER PLOVERS

Of the thirteen plovers we may observe in North America, four are wanderers from foreign shores. One of these, the European Lapwing, *Vanellus vanellus,* can be immediately recognized by its streaming black crest. It was this bird that made one of the most notable flights in the annals of birdlore in 1927, flying twenty-two hundred miles across the Atlantic to Labrador. The lapwings were driven by powerful wind currents and of course did not purposely set out

for America! This was the year in which Lindbergh made his famous nonstop flight from New York to Paris, negotiating thirty-six hundred miles in thirty-three hours.

Some Old World plovers are colorfully adorned with accessory plumes. Of these, the most extraordinary is the large Wattled Plover, *Lobibyx,* of Australia—it sports a fleshy yellow masklike wattle which hides the base of its bill and the front of its head. The red legs and wing spurs are also striking in appearance.

Coming back to American plovers, we find the Surfbird, *Aphriza virgata,* on the Pacific coast. It has gray plumage, flies swiftly, and seems to enjoy standing where it is showered by spray from the surf. Its nest remained undiscovered for a long time, but naturalists finally found it high on the slopes of Mt. McKinley in Alaska. On Atlantic beaches we may often see the pale, sand-colored Piping Plover, *Charadrius melodus,* or hear its mournful whistle.

AVOCETS AND STILTS—LONG-LEGGED WADERS

The avocets and stilts make up a small group of shore birds that frequent warmer regions than those preferred by most true sandpipers. The family is known as the Recurvirostridae.

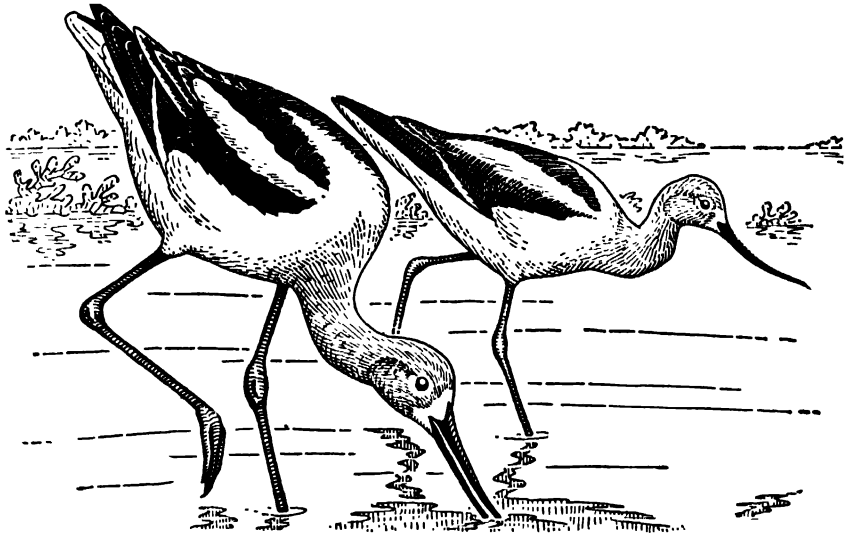
The American Avocet, *Recurvirostra americana,* has a long bill which, as its scientific name informs us, is curved upward. It is plentiful around the alkali lakes of western North America. Up to twenty inches long, the avocet is a large, handsome shore bird with very long legs adapted for wading. Its plumage is varied with white, tan, and buff. The male and female take turns incubating—as one of a pair daintily picks its way over the alkali flats towards the nest, its mate will rise from the eggs and depart. To see this, however, you must be well concealed, for the avocet is very noisy and aggressive when humans approach its nest.

East of the Mississippi, hunters wiped out the avocet, which was once considered a good game bird.

The Black-necked Stilt, *Himantopus mexicanus,* is aptly named, for no other bird has such disproportionately long legs. The stilt spends much of its time wading in shallow water, for which its dangling, almost grotesque legs are well adapted. As if the legs needed anything to make them more noticeable, their red color contrasts vividly with

this bird's plumage—black above, white below. The stilt is about thirteen inches long, the legs about seven inches.

Stilts often nest in the company of avocets in the western United States, and they also dwell in the Southeast. The stilt has close relations in the warmer parts of the Old World. During World War II many American servicemen got their first view of the Hawaiian Stilt, a common bird on the mud flats near Pearl Harbor.



THE AVOCET'S REMARKABLE BILL

Many birds have a long bill, but the avocet's is remarkable because it curves upward. This good-looking bird has very long legs suitable for wading. Avocet parents take turns incubating their eggs, and raise a din if their nest is approached. The avocet is often found in the company of its relative the stilt—a bird that, in proportion to size, has the longest legs of any known bird.

PRATINCOLES AND COURSERS

The most remarkable bird in this group is a courser—the Crocodile Bird, *Pluvianus,* which—so we are told—enters the gaping mouth of the Nile crocodile in search of leeches.

There are twenty-three species in this Old World family (the Glareolidae), which is partial to the warmer regions. The Common Pratincole ("meadow inhabitant"), *Glareola pratincola,* is perhaps the best known of these birds. It has long, pointed wings, a forked tail, and

weak feet. In flying, it uses the swallow's technique of catching insects on the wing. The common pratincole nests in the Mediterranean area.

The coursers, as you can gather from their name, are strong runners rather than fliers. Both pratincoles and coursers are partial to hot, dry plains or mud flats. Their nesting habits are much like those of other shore birds.

PHALAROPES—THEY WEATHER THE WINTRY GALES

The three species of phalaropes, or sea snipes, are extraordinary birds, not least in their feeding habits. They have a weird habit of spinning rapidly round and round in the water when eating. This probably attracts tiny water-dwelling creatures to the surface where the birds can snap them up with their bills. One observer counted some 250 consecutive turns by a phalarope—which the bird negotiated without losing its balance!

Phalaropes differ from most birds in their courting and nesting habits. The male is duller-colored than the female; she is the dominant partner when it comes to courting, while he assumes a coy attitude. Later, the male incubates the eggs and cares for the young by himself. When they have donned their breeding plumage, phalaropes —especially the females—have a bright feather pattern of chestnut, black, and white. This pattern is different for each of the species, but with the coming of winter they all molt into a dull plumage, leaden gray above and white below. They are small birds, eight to ten inches long.

What is perhaps most remarkable of all about the phalaropes is that, despite their kinship to the shore birds, they are able to live at sea in the wintertime. Two species, the Northern Phalarope, *Lobipes lobatus,* and the Red Phalarope, *Phalaropus fulicarius,* nest in the grim Arctic regions of both hemispheres. The remaining species of the family Phalaropididae, Wilson's Phalarope, *Steganopus tricolor,* nests in marshes in the interior of North America. They are well adapted for life at sea with their weblike toe lobes, flattened legs, and dense, gull-like plumage. At times they visit American shores during a storm; as a rule, however, they remain at sea except during nesting time. Our knowledge of their wintering "grounds" is on the sketchy side, but we do know that these areas cover vast stretches of southern ocean.

Flocks numbering in the tens of thousands remain at sea for months at a time, feeding on tiny creatures in the sea and weathering the gales with a skill and fortitude that comes naturally to them.

CRAB PLOVERS

The peculiar Crab Plover, *Dromas ardeola,* differs from other shore birds most sharply in its nesting habits. Instead of the orthodox three or four eggs, it lays a single white egg at the end of a burrow dug by the birds. The young crab plover is reported to remain in this burrow for some time, whereas the young of most shore birds are able to follow their parents around a short time after hatching.

The crab plover, which is placed in the family Dromadidae, lives in sandy areas on the coasts and islands of the Indian Ocean. A long-legged, black-and-white shore bird with a heavy black bill, it feeds on crabs and other small creatures of the shore line.

THICK-KNEES—SHORE BIRDS WITH A DIFFERENCE

Some birds have misleading names, and you may therefore wonder about the basis for the thick-knee's name. In this case, however, the name is quite accurate, for these birds, also known as stone plovers or stone curlews, are remarkable for their prominent, bulging "knees." Ranging in length from one to two feet, the nine species of the family are modestly colored in gray and brown. They all have three toes, long legs, large eyes, and oval nostrils—other shore birds have slit-like ones. Though they dwell chiefly in the warmer portions of the world, one species nests in England.

Thick-knees—they make up the family Burhinidae—are fond of stony areas bordering rivers and lakes, though we find some kinds on sandy deserts or grassy plains containing a scanty covering of bushes. They take their ease in the shade of bushes by day, going abroad at night to feed. When threatened by a daytime intruder, they sometimes try to hide by stretching out on the ground. They travel or forage alone or in pairs, run swiftly, and fly strongly. Their nest is a depression in the ground in which they lay two or three gray, sparsely spotted eggs. They feed on snails, worms, and insects.

The Noisy Thick-knee, *Burhinus bistratus,* ranges from southern Mexico to northwest Brazil. We have taken this huge "shore bird" of the night on the *llanos* (plains) of Venezuela and Colombia, coming

upon it while we were hunting with a jacklight to gather birds for scientific purposes. This thick-knee is most remarkable for its great yellow eyes, large heavy bill, and green legs.

The Great Thick-knee, *Esacus recurvirostris,* of southern Asia stands a foot and one-half high and has a total length of nearly two feet. As we can tell from its scientific name, the heavy, sharply pointed bill is curved upwards.

SEED SNIPE—THEY FLOCK TOGETHER

These peculiar grouselike birds of South America and the Falkland Islands almost invariably travel in flocks. Such groups sometimes number fifty or more and it is not unusual for them to permit a horseman to ride through their midst without taking flight. When unmolested, the birds creep slowly about, calling to one another with deep pigeon-like whistles. They are crafty when it comes to concealing themselves, and it is very hard to flush them. If, at length, they are flushed, seed snipe rocket upward like snipe, twisting and uttering a sharp grating cry. In the air the flock maintains tight formation and travels with great speed.

We find the strongly migratory seed snipe at sea level in Patagonia, and again up to fourteen thousand feet in the Bolivian Andes. The Patagonian species winters on the pampas of northern Argentina.

Seed snipe range in length from six to twelve inches; the smallest types remind us of quails. The four known species all have comparatively stout bodies, short, weak legs, long and sharply pointed wings, and plumage with a fowl-like texture. Though they make up a very distinct family (the Thinocoridae), seed snipe are cousins of the shore birds.

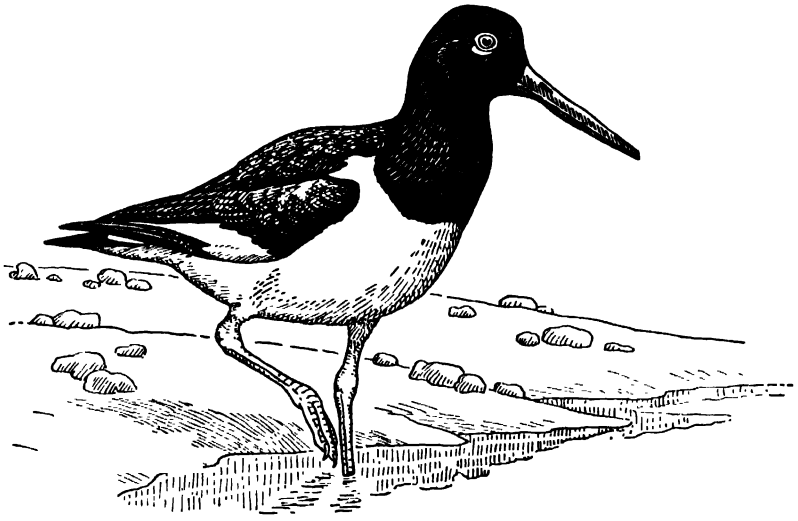
As their name indicates, seed snipe feed almost exclusively on vegetable matter—mainly seeds. These birds nest in a grass-lined depression in the ground. Here the female deposits three to four pale-gray or pinkish-gray pear-shaped eggs, thickly spotted with brown. Observers have reported that she covers the eggs with grass when she is not incubating them.

OYSTER CATCHERS

Some bird names, such as the tropic bird and bird of paradise, have romantic connotations. Other names are plain and sternly functional, telling you at once how the bird gets its living. Such a one is the oyster

catcher, which does just that: It catches oysters. When feeding, it wades in shallow water and quickly jabs its strong, sharp-edged bill into the opened shell of an oyster or clam, cutting the flesh so that the victim is unable to clamp shut on the bird's bill.

Making up the family Haematopodidae, the six species of oyster catchers—or mussel pickers, as they are called in England—dwell along seacoasts over much of the world. In the Eastern Hemisphere they also wander up large rivers. Sizable and conspicuous shore birds, these oyster catchers usually have black and white plumage with a red bill and legs. Often they travel in flocks.



A BIRD THAT LIVES ON OYSTERS AND CLAMS

The oyster catcher, a wading bird of the seacoast, lives on oysters and clams, jabbing its strong, sharp bill into the opened shell of these creatures and paralyzing them. A wary bird, the oyster catcher, it is said, will sometimes carry its eggs away, one at a time, at the approach of an intruder.

The female lays several spotted eggs in a depression in the beach. If a human observer comes too close for comfort, an incubating bird is said to sometimes carry its eggs, one at a time, between its legs to a new location. Normally wary, oyster catchers drop their caution at the approach of an intruder to their nest; they fly about and scream noisily.

The Common Oyster Catcher, *Haematopus ostralegus,* appears on coasts in many parts of the world. On the East coast of North Amer-

ica it nests from Virginia south; in the West the Black Oyster Catcher, a variety of the same species, ranges as far as Alaska.

SHEATHBILLS—THEY HAVE TO BE RESOURCEFUL

Living in the bleak antarctic wastes, where the sea is the ultimate source of all food, the sheathbills are the only birds in that desolate region without webbed feet. They are bold and aggressive—they have to be. Traveling widely, they visit colonies of penguins and other seafowl, where they are quick to eat any neglected eggs or almost anything else that is edible. Man they hold in so little respect that they may sometimes be picked up by hand.

There are two species of these stocky white birds, not unlike a pigeon in size and appearance. The horny sheath that covers much of the bill gives the birds their name. Though they have no close relatives, we may think of the sheathbill family (Chionidae) as shore birds of rather an unusual kind. The oyster catchers are perhaps their nearest kin.

GULLS AND TERNS—FROM SALT OCEAN TO SALT LAKE

We think of the gulls and terns as seacoast birds; yet the terns include the world's champion long-distance migrator, while one species of gull has been honored by a monument for valuable services rendered as far inland as Salt Lake City!

However, the gulls and terns do have many physical similarities, and they share many traits in common. For example, they are both elegant and powerful fliers, they have a marked fondness for fish, and many of them nest in large colonies.

GULLS—VALUABLE SCAVENGERS OF PORT AND HARBOR

Gulls are among the most graceful of all flying birds, and their alternations of wheeling and dipping are a delight to the eye. They spend quite a bit of time resting on the water; thoroughly at home in that element, they swim well, aided by their webbed feet. The slightly curved bill is strong, suitably so for a roving, alert bird that is always on the lookout for a morsel of food.

Gulls are large or medium-sized birds, usually white, though the back and upper surfaces of the wings—usually called the "mantle"

—are often washed with gray or black. In many gulls we observe that the head is black during the nesting season, and often we see black marks on the flight feathers. Gulls and terns are placed in the family Laridae.

The Herring Gull or Common Sea Gull, *Larus argentatus,* is the most familiar of all the gulls. An avid scavenger of all kinds of garbage and refuse, it will eat almost anything in the way of food. Its resourcefulness is proverbial; it will probe for mussels with its bill, snatch them up, soar some fifty feet in the air, drop them to the ground to smash the shells, and extract the contents. It has been known to snatch fish stuck in a pelican's bill.

We always find gulls in quantity along coasts, in harbors, near fishing vessels. It has been calculated that there are seventy-five thousand gulls in New York Harbor, where they render a valuable service in mitigating pollution by consuming large amounts of refuse. Despite their scavenging habits, they are exceptionally clean birds.

Gulls survive the fiercest storms at sea, and they rest by sleeping on the waves. They get along well on land, too, and flourish in the severest extremes of climate.

Large nesting colonies are the rule for herring gulls. They lay their three heavily marked eggs in a crude nest of seaweed. They make solicitous parents but may be very harsh toward the young of other gulls. While they are generally sociable creatures, they can be very quarrelsome at times. The baby gulls announce they are hungry by tapping a red spot on the grownups' bills.

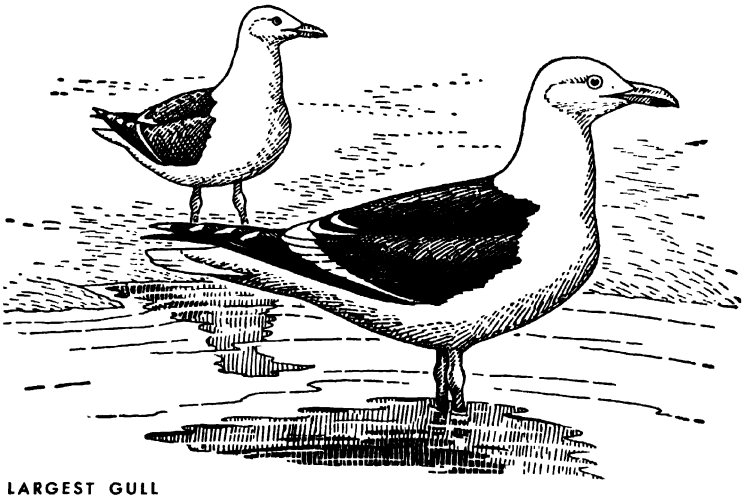
Years ago thousands of gulls used to be killed for their feathers, but now the birds are protected by law. Partly because of this protection, partly because of the growth of great seaports surrounded by garbage dumps, the gulls have multiplied enormously. In Maine and Canada the authorities control the herring gull colonies by gathering the eggs or spraying them with a strong chemical. On Bonaventure Island in the Gulf of St. Lawrence, where we found this gull nesting in scattered colonies on the rocky shores, it was very destructive to the eggs and young of the local members of the auk family. In other places it preys on eider ducks, terns, or other more desirable species—so we see there is a real need for rigorous control.

The herring gull is one of the largest birds of the gull clan. Up to twenty-six inches long, it has a wingspread of almost five feet. Its flying speed is about thirty-five miles an hour.

The Franklin Gull, *Larus pipixcan,* is one of the gulls that nest in land, though it is true that gulls are commonest on seacoasts. It feeds chiefly on insects which it catches in flight or on the ground. To this trait it owes its famous Salt Lake City monument—a tall marble shaft topped by a ball on which two gulls have just landed. About a hundred years ago a plague of crickets threatened to destroy the crops of the pioneer Mormons who had recently arrived in the West. The menaced crops were saved by flocks of Franklin and California gulls which wiped out the pestiferous insects by what must have seemed like a miracle to the farmers.

Although several kinds of gulls are migratory, the Franklin gull is the only northern species to penetrate into the Southern Hemisphere. "Prairie pigeon" is another name given to this bird in the interior of the United States. It breeds in large colonies on marshes, and lays two or three eggs.

The Great Black-backed Gull, *Larus marinus,* is the largest of all the gulls. Reaching a total length of thirty inches, it has a wingspread to sixty-six inches. Timid in man's presence, it is a bold robber of other



THE LARGEST GULL

The good-looking black-backed gull, some thirty inches long with a wingspread of sixty-six inches, is the largest of all the gulls. This gull is as resourceful as its cousins when it comes to obtaining food, and boldly steals from other birds.

birds' food and eggs. You can readily distinguish its deep-pitched cries from the raucous screaming of the herring gull or the noisy gabble of the Laughing Gull or other lesser species. In recent years this handsome bird has nested on the eastern coast of Long Island in New York but its stronghold is much further north.

At the other extreme in size is the Little Gull, *Larus minutus,* a bird of European and Asiatic waters. Of late years it has appeared in small numbers every winter in eastern North America.

Most gulls, as we have seen, are hardy birds. A case in point is that of the Rosy Gull, *Rhodostethia rosa,* which nests in the Arctic regions and apparently winters along open leads of water in the Arctic Ocean. Like many gulls and terns, it has a beautiful rosy bloom on the breast.

The Bonaparte Gull, *Larus philadelphia,* another species that breeds in the north, builds its nest in the tops of spruce trees instead of on the ground as other gulls do. Its young remain in the nest, unlike the young of other gulls, which scramble about near their nest. (Baby gulls, however, are by no means the equals of most young shore birds when it comes to running.) The Bonaparte gull is about fourteen inches long, with a wingspread up to thirty-two inches. When it travels further south it destroys a great many insects, sometimes on the wing, in the inland regions where it lives a good deal.

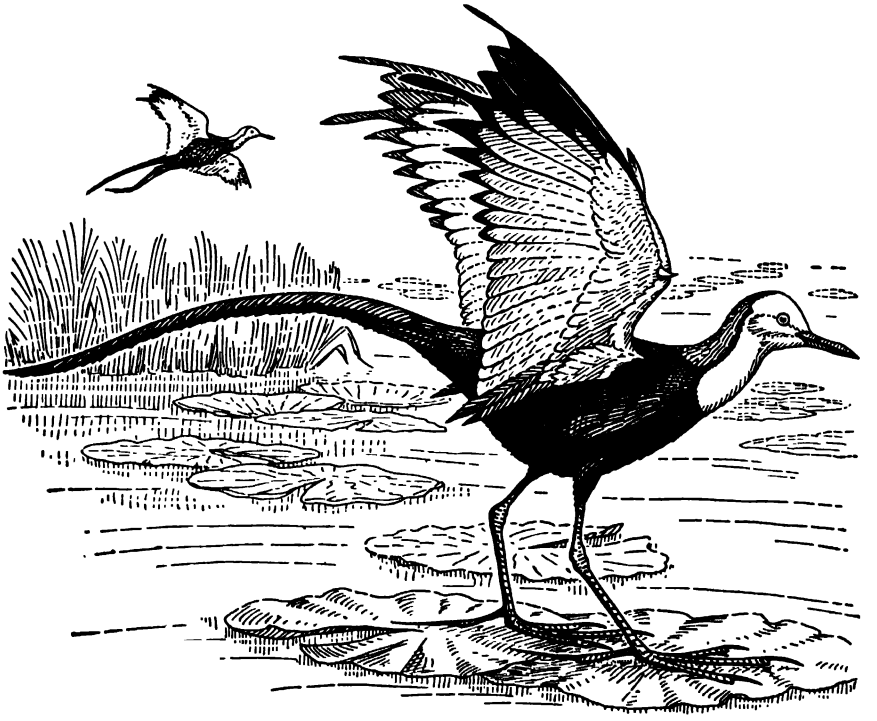
TERNS—THEY INCLUDE THE CHAMPION MIGRATOR

The Arctic Tern, *Sterna paradisaea,* is famous for its annual round-trip migratory flight of some twenty-two thousand miles—the longest migration of any known creature. The individuals undertaking this amazing journey first enjoy nearly four months of continuous daylight on their breeding grounds during the Arctic summer, followed by four months of almost continuous daylight on their Antarctic wintering grounds. These birds live to within eight degrees of the North Pole during their Arctic sojourn. However, some birds of this species nest as far south as Massachusetts—nor do they all reach the Antarctic during their migrations. In appearance the Arctic tern is typical of this tribe of water-loving birds. White below and gray above, it has a black cap, and scarlet legs and bill.

Terns are so graceful in flight that we sometimes call them "sea

up rather than down, this specialized footwear enables the jaçana to run over the filmiest of plant rafts without sinking. This trait inspired someone with a sense of humor to dub the jaçana a "lily-trotter." The hind toenail of the Lotus Bird or Combcrested Jaçana, *Irediparra gallinacea,* of Australia, is three and one-quarter inches long!

Jaçanas dwell in the warmer portions of the world. Slender birds with a long, tightly feathered neck and body, they have gangly legs and well-developed wing spurs. The body is no larger than a robin's. These birds are shy, but they fly vigorously. Upon alighting, they hold the wings elevated for a moment, as do many shore birds. In the air they let their long legs and toes trail nearly horizontally behind them. Their fare is made up of water insects, mollusks, and plants. These birds are grouped in the family Jacanidae.



LILY-TROTTER AND LOTUS BIRD

These are two of the names given the jaçana, a bird which spends much of its life on floating vegetation. Jaçanas have long toes and claws to enable them to run across the most delicate water plants without sinking. One species has a hind toenail more than three inches long. The pheasant-tailed jaçana, pictured above, has a tail a foot long.

Though similar in color, the female jaçana is about twice as large as her mate—so you will not be surprised to learn that by human standards the male is a henpecked creature, burdened with most of the domestic chores. The nest is generally a flat—sometimes a cup-shaped—structure, made of slender-leafed water plants and in some cases of considerable size. It is often placed in short matted grass close over water, and on occasion left partially afloat. The two to four glossy eggs are buffy, cinnamon, or even green with scroll-like black markings.

The American Jaçana, *Jacana spinosa*, lives in tropical America as far north as southern Texas. A deep reddish-maroon bird, it has pale apple-green wings, while its head and neck are greenish black. The orange wattle on the forehead adds still another color to the ensemble. The species name *spinosa* refers to the sharp, horny wing spurs which the bird probably uses for fighting.

The Pheasant-tailed Jaçana, *Hydrophasianus* ("water pheasant") of tropical Asia, is the largest as well as the most peculiar of these peculiar birds. Its tail is more than a foot long. The dark areas of its gaudy plumage are purplish maroon; the light areas are white, except on the hind neck, which is glossy gold.

AUKS, MURRES, PUFFINS, AND THEIR RELATIVES

These birds dwell on the desolate seas and islands of the Northern Hemisphere, mostly within the Subarctic or Arctic Zones. They get their food in a remarkable way—they seize fish and crustaceans by diving from the surface and "flying" under the water. No less than nineteen of the twenty-two species of this family, the Alcidae, are present at some time of the year along American coasts. In the East none nest south of Maine, but in the West two species nest on islands in the Gulf of California. In winter some auks wander farther south.

AUKS—BULLET-LIKE FLIERS

In habits and appearance auks are the northern equivalent of the penguins of the Antarctic. However, the auks are smaller birds and all surviving species are able to fly. Thus they are less highly specialized for ocean life. Nevertheless, auks spend much of the year at sea, gathered in loose flocks. They fly in bullet-like fashion with rapid wing

beats, usually staying together in flocks or strings and frequently barreling down to the water with great clumsy splashes like a skipped stone as they dash after fish. In the spring, when they establish large nesting colonies on oceanic islands, and later in the year on the wintering grounds, it is customary for several species to consort together.

Although we find several interesting auks in the Atlantic, their real stronghold is the North Pacific. There, on the bleak coasts of the Aleutian Islands, a great variety of species turn up in countless throngs. Many of them are grotesquely ornamented with whisker-like facial plumes or growths on the head. The Ancient Murrelet, the Rhinoceros Auklet, and the Horned Puffin—creatures as quaint as their names—will be among those greeting the naturalist who visits this region.

MURRES AND THEIR GROWLING MOANS

Breeding murres and auks are strangely tame and as one wanders among them, as we did on Funk Island off the north coast of Newfoundland in 1936, they keep up a constant growling moan. With their black upper parts and heads and gleaming white breasts, they remind us of a convention of disgruntled waiters.

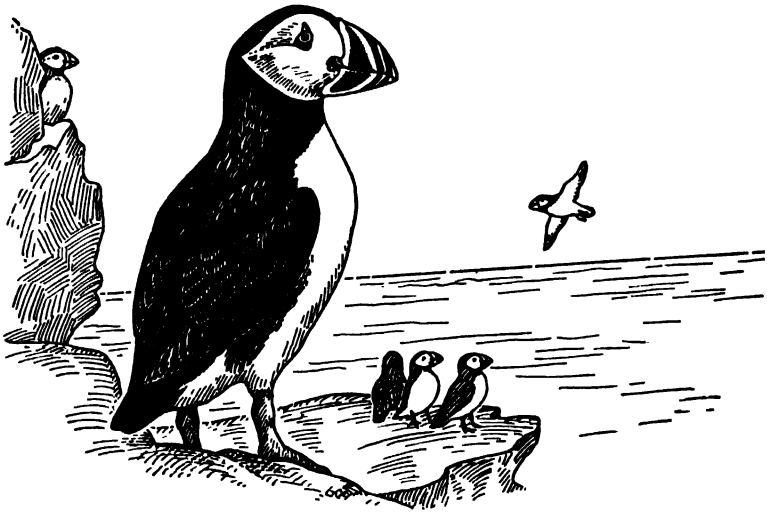
The Common and Brunnich's Murres, *Uria aalge* and *Uria lomvia,* lay a single, relatively huge, pear-shaped egg, blotched variably with black and brown. They build no nest; the egg remains on the ground and, because it is cone-shaped, rolls no farther than the radius of a small circle. The downy young murres have sooty and grayish breasts. Their parents feed them by regurgitation.

PUFFINS—COMICAL BUT ADROIT

The Atlantic Puffin, *Fratercula arctica,* is a comical-looking bird with its rather large black head with a gray collar, its disproportionately large, stubby blue and crimson bill, its white cheeks and under parts, and its red legs that afford it nothing better than a clumsy waddling gait. The harsh croak is what might be expected from this grotesque figure. For all its whimsical appearance, the puffin is quite business-like in its fishing technique. Whenever we saw a puffin with its usual catch of five to ten smelt, each hanging limply by its gills from the bird's bill, we marveled at the puffin's ability to seize additional fish

without dropping those previously captured. The bill, by the way, has an outer shell that the bird sheds and then grows anew each year.

Puffins dig nesting burrows in the earth and line them with a crude nest of feathers and grass. The single whitish egg is incubated for nearly five weeks, both parents taking part.



THE GROTESQUE PUFFIN

Few birds can match the clownish appearance of the Atlantic puffin. It has a big black head, an oversized blue and crimson bill, white under parts, and red legs. The comical effect is enhanced by its clumsy waddle and harsh croak. The puffin replaces the outer shell of its bill each year.

THE GREAT AUK—MADE EXTINCT BY WHOLESALE SLAUGHTER

Much has been written about the North Atlantic Penguin, Garefowl or Great Auk, *Pinguinus impennis,* the largest and only flightless member of the family Alcidae. The very last great auk was killed more than a century ago (1844). Yet only a few years before that they abounded in the waters of the North Atlantic, breeding by the thousands on the islets off the coast of Newfoundland, Greenland, Iceland, and the Orkneys. Today this remarkable bird, aside from the accounts of early travelers, is known to us only from a few stuffed birds, eggs, and skeletons. Total extinction was visited upon the great auk with such amazing rapidity largely because of its almost suicidal

instinct to return to its ancestral breeding grounds. Here the sealers slaughtered it both for its oil and its plumage.

On Funk Island, one of the last homes of the great auk, we unearthed some seven thousand bones in less than five hours during our brief visit in 1936. All but a handful were those of the great auk, which gives you some idea of the magnitude of the slaughter that took place three generations ago. Here it was that we came upon stone corrals or pens, with walls averaging about two and one-half feet high, into which the great flightless birds were herded like sheep to be slaughtered and defeathered in huge caldrons heated by the burning bodies of their fatty brethren. Jacques Cartier, who first discovered this colony in 1535, recorded in his log the restocking of the ship's larder with great auks.

DOVEKIES—SMALLEST OF THE FAMILY

At the other extreme in size from the great auk is the Dovekie, *Plautus alle,* about nine inches long. The Eskimos catch great numbers of dovekies in nets on the nesting cliffs. The birds are then stuffed into sealskin bags and cached away until winter.

The dovekie is black above, white below, and has a white streak above the eye. Rarely do dovekies get as far south as the United States except during influx years when, as in November, 1932, a great wave of them surged down the coast, and even spread some distance inland. Most of these birds probably perished.

Pigeons, Doves, Dodos, and Sand Grouse

THIS ORDER, which includes one of the best known of all birds, also has the melancholy distinction of containing two famous birds that were exterminated by man. One of them was so far away from our conception of a bird that it has taken on the proportions of

a mythical creature; the other was indeed a typical bird, the most abundant in North America according to some; the most abundant in the world, according to others. The pigeons, doves, and their relatives make up the order Columbiformes.

PIGEONS AND DOVES

This is a large family—some 290 species, including the popular Domestic Pigeon or Rock Dove, *Columba livia*. If you are familiar with this famous citizen of the bird world, you would have little difficulty recognizing almost any pigeon or dove as belonging to this family, known as the Columbidae. For they all have the same soft, sleek, rather small and rounded head, plump, full-breasted body, and short, soft-skinned legs and toes. The bill is rather slender and is partly covered with a delicate growth ("cere"). The feathers are dense but usually smooth. They are loosely attached, especially those on the back. There is a theory that this is a useful adaptation—when a falcon swoops upon a fleeing pigeon a cloud of feathers is loosened, and in the ensuing confusion the pigeon sometimes makes good its escape.

THE DIFFERENCE BETWEEN DOVES AND PIGEONS

What is the difference between "doves" and "pigeons"? None, really, though we use the former term more often for the smaller, gentler members of the family—the symbolic "dove of peace." Weakly represented in the Northern Hemisphere, this group is much more numerous in the tropics of America and Africa. But it is in Australia, New Guinea, and on the islands of the Pacific that pigeons and doves are found in greater variety and profusion of species than anywhere else in the world.

WAYS OF THE PIGEONS

The ardent cooing and strutting of the male pigeon of our parks are typical of the whole family. Equally characteristic are the notes of these birds, with their almost invariably soft cooing or hooting quality, the melancholy effect often enhanced by monotonous repetition. Mated pigeons are deeply attached to each other, and if one of a

pair meets with a mishap it will take some time before the other accepts a new partner.

All pigeons lay unspotted white or buffy eggs. All the better-known kinds lay two eggs in a set, but a few tropical species lay only one. The nest is a flimsy, untidy structure. Both parents incubate, the male usually by day and his mate by night. After the young hatch, they are fed on "pigeon milk"—a unique substance secreted by the lining of the parent's crop and then pumped into the mouths of the young. This feeding method is thus strictly comparable to that of milk production by mammals and is quite unlike any feeding process found elsewhere among birds. Another distinctive trait of pigeons—though they share this one with a few other groups—is their ability to stick the bill into water and drink without lifting the head to swallow.

Most pigeons are strong, swift fliers. This, together with their palatable flesh, makes them favorite game birds in many parts of the world. In desert regions, where they come morning and evening to water holes to drink, they are often shot along the lines of flight. However, pigeons reproduce too slowly to be shot indiscriminately as game birds, and a number of species are already menaced by the prospect of extermination.

The "Carrier" or "Homing" Pigeon (one of the numerous varieties of the domestic species) is famous for its homing feats. Actually, it has less homing ability than many wild birds! With training, however, it quickly becomes proficient. Speeds of about sixty miles an hour are common, and the maximum homing distance is in the neighborhood of twelve hundred miles. Pigeon racing is a widespread hobby that is not without its practical side in wartime. During World War I and after, the United States Signal Corps trained homing pigeons, and some rendered valuable service.

AMERICAN PIGEONS AND DOVES

The Passenger Pigeon, *Ectopistes migratorius,* became extinct in 1914 when the last known bird of this species died in the Zoological Gardens at Cincinnati. Back in 1605 the French explorer Samuel de Champlain observed passenger pigeons in "infinite numbers" in Maine. In the days of the young Republic, these birds perched on trees in such dense groups that they broke the boughs by sheer weight. Migratory flocks, miles long, darkened the sun and took hours

to pass a given point. Alexander Wilson, the "Father of American ornithology," estimated that one such throng observed by him near Frankfort, Kentucky, about the year 1808, contained over two billion passenger pigeons. And yet we know that by the turn of the century these birds had become very scarce. What had happened in the intervening years?

Man was the culprit. First he mass-slaughtered the passenger pigeons for food for himself, then for pigs, even bringing the swine to the roosting places to devour the victims. It was fantastically easy to shoot the birds, but it was cheaper and quicker to blind them with torches and club them to death, or to suffocate them by burning sulphur under their roosts. Thus these once abundant birds were wiped out.

The Mourning Dove, *Zenaidura macroura,* is the only common species over most of the northern United States and Canada now that the passenger pigeon is gone. Also known as the Turtle Dove, the mourning dove does not nest in dense colonies as did the passenger pigeons, and so has survived in goodly numbers. Mourning doves, when mated, are among the most affectionate honeymooners in the bird kingdom, and their absorption in each other is proverbial. Apparently they give little attention to such practical matters as nest-building, for the structure is usually a flimsy affair, set up without an eye to the best shelter and protection. The two white eggs are consequently at the mercy of crows, snakes, cats, and other enemies. Perhaps as nature's way of making up for these hazards, the doves produce two or more broods during the mating season.

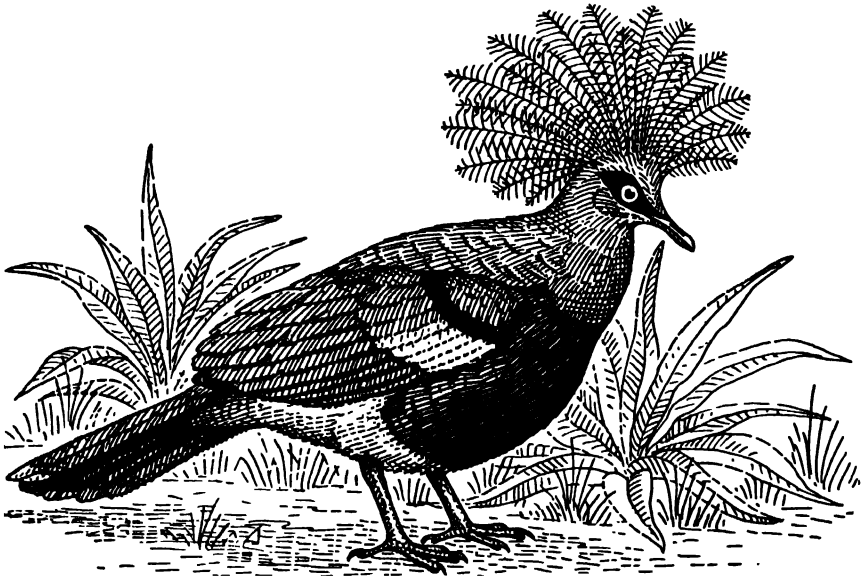
Mourning doves feed mostly on seeds, which does not endear them to the prosaic farmer. They have a familiar call of "coo-wee-oo, coo-o-o, coo-o-o, coo-o-o," which may strike you as gentle or mournful, depending on your mood. These birds spend the winter in Mexico and the southern states.

The appearance of the mourning dove is quite similar to its vanished cousin's, but the passenger pigeon was somewhat larger and had a strong reddish tint on its breast. A slender bird, the mourning dove is brownish, tinted with lavender. The tail is pointed and you can see the large white spots near its tip when the bird takes off or alights. Whenever the mourning dove springs into the air its wings beat together noisily—a characteristic of many doves.

In the southern United States the little Ground Dove, *Columbigallina passerina,* often flutters up under foot. You can recognize it easily by its small size—a seven-inch length is the maximum—and its chestnut wing patches. A slightly larger species, the Inca Dove, *Scardafella inca,* is common in the gardens of Tucson, Arizona, and other southwestern cities. Its repetitious two-syllabled call, sounding like "wa-hoo," can be heard even during the noontime hush of a summer's day, when the heat has lulled every other bird into silence.

EXOTIC PIGEONS OF THE TROPICS

The tropics abound in many colorful or unusual pigeons. The Fruit Doves of the Polynesian islands (genus *Ptilinopus*) are among the loveliest of all birds. The top of the head is often violet, and the rest of the color pattern consists of softly blended pastel shades of green, yellow, and lavender. As we can gather from the common name of



PIGEON OF THE TROPICS

The crowned pigeon, a bird of New Guinea, is the largest member of the pigeon family and also one of the handsomest. In common with other pigeons, it feeds its young on "pigeon milk"—a fluid secreted in the lining of the parent's crop and then pumped into the babies' mouths. This technique is practiced by no other bird. Because of its curiosity and fearlessness, the crowned pigeon is doomed wherever man settles.

these birds, they live chiefly on wild fruits. This is also true of most members of the family, though many species include seeds and nuts, as well as fruit, in their fare.

Pigeons are noted for their soft, smooth plumage, but the Nicobar Pigeon, *Caloenas nicobarica,* is an exception; it has long, loose, pointed feathers that give it a shaggy appearance. The plumage is blackish, glossed with purple and bronzy reflections, and the tail is white.

The largest members of the family Columbidae are the Crowned Pigeons, *Goura,* of New Guinea, which are the size of a large chicken. They are handsome birds with maroon body plumage, gray wings, and a pearly crest of lacy head plumes running the length of the crown.

DODOS AND SOLITAIRES

Twice as large as a goose, flightless, with thick stubby legs and long "pants," a poodle-like tail complete with curls, tight pigeon-like body plumage, a tremendous skull equipped with a stout, heavily plated and deeply hooked bill, a naked face and dog-sized mouth, the Dodo, *Didus ineptus,* was perhaps the most un-birdlike bird that ever lived.

Extinct for centuries, the dodo yet contrives to hold its place as one of the best known of birds—possibly because so many of us are introduced to it at an early age by reading *Alice in Wonderland.* The bird was first discovered by the Portuguese in 1507 and last seen alive in 1681. Thereafter it lapsed into the realm of fantasy. Most people took a skeptical view of the early sketches and accounts which depicted so preposterous a creature—this despite the fact that a number of live dodos were brought to Europe early in the seventeenth century.

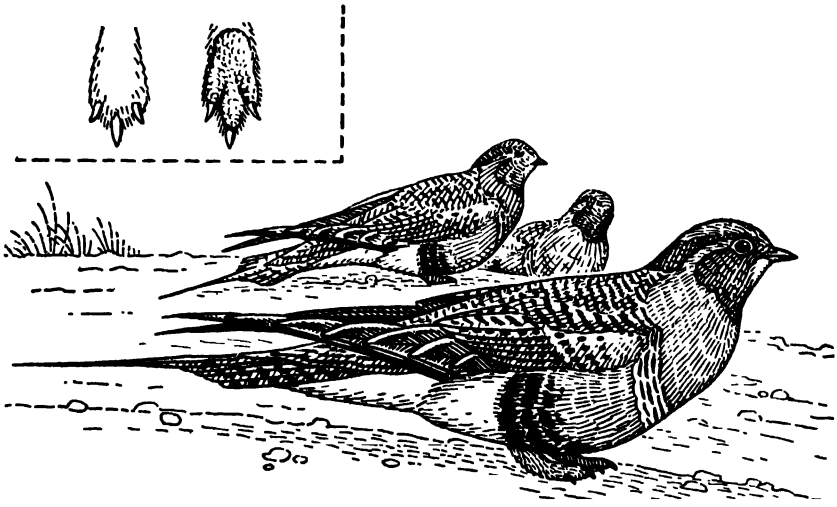
What traces of the dodo remain? Specimens of the head and feet are preserved at Oxford, and a number of skeletal parts are scattered around the world in collections. In 1907 the American Museum of Natural History acquired the bones of a dodo in a swap for the skeleton of a Right Whale.

The true dodo lived on the island of Mauritius in the Indian Ocean, about five hundred miles east of Madagascar. Another species, *Didus borbonicus,* was found about a hundred miles away from Mauritius on the island of Réunion, while the Solitaire, *Pezophaps solitarius,* a smaller, less peculiar dodo, made its home on nearby Rodriguez Island.

All these birds, which made up the family Raphidae, are extinct but, luckily, a few hints of their habits were recorded before their early disappearance. From these accounts we gather that the dodos—now acknowledged to have been monstrous, flightless pigeons—lived in deep forest, walked with a ludicrous waddle, and laid one large egg which both parents incubated. They swallowed gizzard stones as large as chicken eggs and sported a rounded knuckle or knob of bone on the bend of the wing. This may have been a handy weapon for squabbling among themselves, but it was of no avail against the pigs introduced by early settlers on these islands. The pigs evidently feasted on the eggs and young birds, and the phrase "dead as a dodo" soon became a tragic reality.

SAND GROUSE

At intervals two or three Asiatic kinds of sand grouse embark on nomadic wanderings like the lemmings', reaching western Europe and even the British Isles. When the wanderlust subsides, the migrants make no attempt to return. Instead, they try to nest in whatever re-



PALLAS'S SAND GROUSE—BIRD OF THE DESERT

Pallas's sand grouse lives on the high, cold steppes of central Asia, where its dense plumage protects it from the low temperatures. Its feathered feet may help support it on the desert sands. Sand grouse of Asia occasionally wander to western Europe and, instead of returning home, try to establish themselves in their new surroundings.

gion they find themselves. In a few years, tragically, all these birds disappear. Yet even in their homeland their lives are beset with danger. Like desert pigeons, sand grouse fly long distances to and from water holes. In India the maharajahs, familiar with this trait, place hunting blinds near water holes and shoot enormous numbers of sand grouse in winter, when the breeding birds of central Asia are wintering there.

The sixteen species of sand grouse make up a small but interesting family, the Pteroclidae. In appearance they fall between the quails and the pigeons. Though sand grouse are probably related to the pigeons, their spotted eggs and downy chicks look quite unlike pigeons'. Protectively colored, they present a blending pattern of brown, buff, gray, white, and black to match the desert sands. The adult birds have a slender, trim appearance, enhanced by a pointed tail. They fly rapidly.

Parrots—Long-lived and Loquacious

You may recall that Long John Silver had a parrot named Captain Flint. The bird often called out "Pieces of eight!" Sometimes it would "swear straight on, passing belief for wickedness." According to Long John, Captain Flint was "maybe" two hundred years old. The parrot had traveled widely—"Madagascar, and at Malabar, and Surinam, and Providence, and Portobello."

If you stop to think about it, you will realize that the parrot is a stock figure in sea stories of bygone times. Parrots are not native to Europe or nontropical Asia; most of the 315 species dwell in the warmer and less accessible parts of the world. The possession of this exotic bird was the sailor's documentary proof, so to speak, of the romantic isles he had visited. And then, the bird was fascinating in its own right—for its ability to "talk," its longevity, the arrangement

of its claws which permits it to "handle" food. For lonely sailors, the saucy, sociable, cynical parrot is ideal company.

Though we associate parrots with warm climates, it is interesting to observe that fossil discoveries indicate the former presence of parrots in Europe and nontropical Asia. There are all sorts of parrots. They range in size from about the dimensions of a small sparrow to the large macaws, some three feet long. All of them are members of the order Psittaciformes and remarkably similar in basic form. Predominantly green, their dress is varied by the addition of red, yellow, blue, white, and black. Long plumes of exquisite color and design enhance the colorful effect.

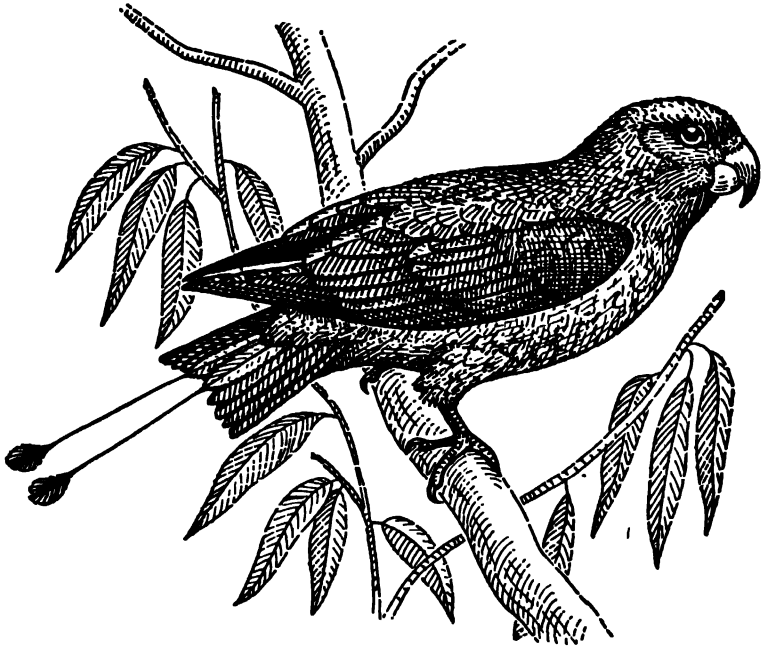
The powerful, sharply hooked bill—the parrot's most characteristic feature—is often deeply notched. The lower half of the bill is short, stocky, and sharply upcurved. It is fastened to the skull by transverse ligaments similar to those of the human jaw. The parrot's neck is short, the head relatively large. In the feet we note a remarkable structure—they are "yoke-toed," with the first and fourth toes extending backward, and they are used like a hand for holding food. This accomplishment is shared by few other birds. As you would expect, parrots walk and climb with sureness and ease, thanks to this arrangement.

These birds fly powerfully, almost always in pairs or flocks, and usually to the accompaniment of raucous, discordant screams. They hiss when defending their nest; at other times they utter shrill whistles. In the wild state they do not imitate other birds or animals. But in captivity, as we know, many species imitate human speech—even laughter or crying, as well as the barking of dogs and the coughing of children. Stories are told of parrots being able to recite the Lord's Prayer and the Apostles' Creed, and it is said that the testimony of parrots has been given partial though not decisive credence in a number of court trials. It seems that the first writer to allude to the parrot's powers of mimicry was Ctesias (about 400 B.C.) in his description of captive African parrots brought to Greece at that early date. In Nero's day the Romans kept parrots in cages of tortoise shell and silver.

The talking ability, longevity (anywhere from fifteen to eighty years), docility, and humor of the parrot have understandably made it one of our best-loved caged birds. Still, because parrots occasionally carry the once deadly psittacosis ("parrot disease"), their impor-

tation was barred until recently. Ornithosis is a better name for this rare virus disease, as it may be transmitted by several kinds of birds. Fortunately the disease has yielded to the modern antibiotics, and parakeets are now almost a fad.

Certain species, such as the African Gray Parrot and the green *Amazona* parrots of South America, have become especially famous as "talkers." Bear in mind, however, that individual birds vary greatly—some learn readily, others "ain't talking."



A PARROT WITH A RACKET-SHAPED TAIL

This medium-sized grass-green parrot was named for its two curiously shaped central tail feathers, which are rather like those of the motmot. The racket-tailed parrot dwells in flocks in the Philippines, where it frequents the tops of lofty jungle trees.

With the exception of one South American species that builds a bulky nest of grass and twigs in a tree, parrots lay their eggs in cavities which they scoop out themselves or appropriate from other birds. The cavity may be in rotting wood, in termite nests, under roots, in earthen burrows, or in crevices in cliffs. Parrots rarely use nesting material. Their eggs are white, the larger species laying two to three and the smaller ones up to a dozen. When it comes to incubating, the

male usually cooperates in the task. The young are quite helpless at birth and are fed by regurgitation. More than one brood may be reared in a season. It often happens that several families of parrots live in a single tree; as we have seen, parrots are sociable birds. Their daily movements to and from a roost are features of the tropical forest, and old-timers will insist that a clock may be set by their noisy, punctual travels. Parrots feed mainly on nuts, seeds, and fruits.

The Papuan Lory, *Vini papou,* which we have observed and collected in southern New Guinea, is typical of the brush-tongued lories of the Australian region. Traveling in flocks in the forest crown, it often perches in the extreme tip limbs of great isolated trees. The beautiful central tail plumes are green on their basal halves and light ocher-yellow on the outer third. The bill and legs are orange scarlet, while the body is largely crimson with the wings, central back, and base of the tail bright green; glossy blue patches occur on the hind crown and rump. To complete this riot of color, the hind crown and shanks or "pants" are jet black. These lories use their brushy tongue in feeding on the nectar of flowers.

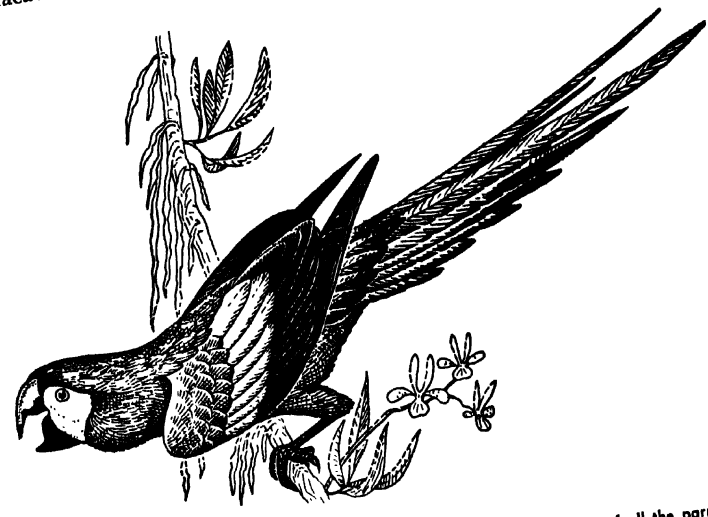
The Pygmy Parrot, *Micropsitta,* is an unbelievable creature, smaller than a Downy Woodpecker and rather similar in shape. It has the stiff spiny tail—useful as a prop—of the woodpecker, and the feet are adapted for climbing on the trunks of trees. The pygmy parrot is a green bird with black crown and ochraceous cheeks.

The Sulphur-crested Cockatoo, *Cacatua galerita,* and the **Great Black Cockatoo,** *Probosciger aterrimus,* are probably the noisiest birds of the New Guinea forests and the best examples of the cockatoos of the Australian region. But, vociferous as they are, they are extremely difficult to approach because of their wary and suspicious nature; they are said to post sentinels.

The great black cockatoo is bluish black and has partially naked cheeks. This feature, its tremendous crest, and massive sickle-bill make it quite conspicuous. The bird uses the bill to tear large grubs from rotting wood and to probe kernels of fruit. It is perhaps the largest of all parrots.

The Red, Blue, and Green Macaw, *Ara chloroptera,* is typical of the large macaws that dwell in tropical America. This brilliant bird ranges from Panama to Bolivia. Its principal colors are evident from its

name, and it has a number of cousins that are every bit as gaudy. With their huge strong bills they can easily crack a Brazil nut and then cleverly extract the meat with the hooked bill and the tongue. Macaws nest in holes in cliffs as well as in hollow trees.



GAUDY BIRD OF TROPICAL AMERICA
The macaw of tropical America is one of the most brilliantly colored of all the parrots. So strong is the huge hooked bill that the macaw has no trouble cracking a Brazil nut and getting out the meat by manipulating the pieces with its tongue and bill.

The African Gray Parrot, *Psittacus erithacus,* is one of the best known of the almost infinite variety of parrots. Famous as a talking bird, it has been shipped abroad in countless numbers. In captivity these birds have been known to survive as long as eighty years. Their coloring is rather subdued for parrots—ashy gray, with red tail feathers.

The Carolina Parakeet, *Conuropis carolinensis,* was wiped out during the present century through excessive hunting by "sportsmen," plume hunters, and farmers. This handsome little parrot, which was yellow and green, with a pointed tail, formerly ranged over much of the southern United States. The late Dr. Frank M. Chapman found a colony of some fifty of these parakeets on the Sebastian River in eastern Florida, and in April, 1904, he saw thirteen on Lake Okeechobee.

So far as we know, the species has not been seen since. Like some other parrots, it was occasionally destructive to fruit, and was often shot for this reason.

LOVEBIRDS AND THEIR RELATIVES

The lovebirds are small Old World parrots, greatly prized as cage birds for their endearing ways. They are so affectionate that they sit together, often with chests and heads touching. One of the most popular and best known is the Rose-faced Lovebird of Africa, *Agapornis roseicollis*. Though the bird is mostly green, it has a red forehead and tail, while the sides of the head and neck are rose. An astonishing trait of these birds is their habit of pushing grass or other nesting material beneath the feathers of their backs and thus carrying it to the nesting burrow in a tree. Other well-known members of the family are the Australian Bruderigar, *Melopsittacus,* which is greenish striped with black, though blue and white varieties have been developed; and the charming little Bat Parrots of the Philippines, which get their name from their strange habit of hanging head downward while slumbering.

OTHER REMARKABLE PARROTS

The blunt-tailed parrots, *Amazona*, are perhaps the most famous of all New World parrots. Gifted talkers and many of them nearly as large as a crow, these birds are mainly green with some red or yellow marks. They range from Mexico to Argentina.

Another notable talking species is the Short-tailed Parrot, *Graydidascalus brachyurus*, of northern South America. A great favorite with the Arecuna Indians of the Guiana highlands, this funny little bird waddles about like a tiny old man. Its upper parts are green, the crown and tail black, the flight quills deep blue with narrow greenish edging, the throat and shanks pale yellow, the chest, hind collar, and abdomen buffy white.

The New Zealand Kea, *Nestor notabilis,* selects living quarters that are quite incongruous for a tropical bird. Disdaining the steaming tropics preferred by its cousins, the kea dwells high in the New Zealand Alps, nesting in rocky cliffs in mid-winter. The bird has a powerful hooked bill which it uses to grub out roots. Unfortunately, when goaded by hunger, it also uses this weapon occasionally to rip open

the back of a sheep. Aside from this one shortcoming, the kea is a charming bird, inquisitive to the point of fearing neither man nor beast.

The Owl Parrot, *Strigops,* another resident of New Zealand, is if anything even more interesting than the kea. The owl parrot cannot fly; it is strictly a ground-dweller. It has the disposition of a bright, lively puppy, and it is so appreciative of kind treatment that it rubs and climbs on its benefactor. Its face looks somewhat like an English sheep dog's, while its general shape is not unlike a Snowy Owl's —hence the name, owl parrot. The two birds are about equal in size, too, but the owl parrot has green plumage, marked with brown and buff.

Formerly this bird was abundant on both North and South Island of New Zealand; now it is found in only remote mountain forests. Making its home in rocky forests, it lays two or three white eggs in earthen burrows. Both parents share the task of incubating the eggs, which take three weeks to hatch. The owl parrot hides under roots and in cavities by day, becoming active in late evening and night. It feeds on grass, weeds, fallen fruit, and seeds. Roaming dogs are now the owl parrot's worst enemy.

Cuckoos and Turacos

THERE ARE cuckoos and cuckoos. Few birds are as disliked as these for their reputed habit of laying their eggs in other birds' nests. What many of us fail to realize, however, is that only one of the New World species is guilty of shunting off the duties of parenthood on its fellow birds; equally little known is the fact that many cuckoos render a valuable service to man by eating vast quantities of injurious insects.

It is the Old World cuckoos that have given this bird a bad name, for many of them are in truth guilty of parasitism. No matter how we feel about this behavior, we cannot help being fascinated by the migrations of the Bronzed Cuckoo, *Chalcites lucidus,* of the Southwest Pacific. The parasitic habits of these birds give rise to one of the most remarkable—and most baffling—of all bird migrations. At their summering grounds in New Zealand, these birds lay their eggs in the nest of flycatchers. The foster parents—they are not migrators—raise the intruders. When fledged, the orphaned young cuckoos fly without hesitation over twelve hundred miles of water to Australia, thence northward another 950 miles to the Solomon and Bismarck Islands, there miraculously joining their parents, who have preceded them there!

CUCKOOS—NOT ALL ARE PARASITES

As we have seen, many Old World cuckoos are parasitic: they lay their eggs in the nests of other birds, usually one to a nest. Cuckoo eggs require a shorter period of incubation. Once hatched, the young cuckoos grow more rapidly than their nest-mates, are usually larger than they, and have an instinctive urge to hoist them out of the nest. You can forecast the likely result: the destruction of the young birds that rightfully belong in the nest.

Some naturalists once believed that the females of parasitic cuckoos first lay the egg and then place it with their bill in the nest of the foster parent. This theory has never been confirmed. What happens is that these female cuckoos carefully hunt for the nests of small birds and then stealthily lay one of their own eggs in it at an opportune moment. After laying the egg, the hen cuckoo takes no further interest in the fate of her egg or her offspring.

However, as far as the New World cuckoos are concerned, with one exception they all build nests and rear their own young.

There are some 130 species in the cuckoo family, the Cuculidae. As regards size, they range all the way from the size of a sparrow to that of a pheasant. We find them around the globe, but they are most numerous and diverse in the African and Indo-Malayan tropics. The brighter birds in the family are brilliantly colored; a few have gaudy accessory plumes. The great majority of cuckoos, however, are brown-

ish with the under parts barred, the tail rounded with white tips, and the bill strong and curved.

When winter comes, the cuckoos, living as they do largely on insects, must migrate to the tropics if they live in the Northern Hemisphere. For example, both the Black-billed and Yellow-billed Cuckoos of the United States migrate to South America every year. Even on its home grounds, the cuckoo is a shy, furtive bird. You are more likely to hear its famous characteristic cry than you are to see it in the flesh.

TRUE CUCKOOS—SOME OF THEM RESEMBLE HAWKS

True cuckoos make their homes in the forests of the Old World. Strong-flying, parasitic, insect-eating birds, they have melodious voices —the well-known cuckoo clock, so beloved by children, is an imitation of the notes of the European cuckoo. The scientific name of the Common Cuckoo of Europe, *Cuculus canorus,* means "melodious." A jay-sized bird looking rather like a small hawk, this bird has gray or brown upper parts, grayish lower parts with dusky bars. Whether because of its hawklike appearance or because of its parasitic habits, groups of small birds in Europe often attack the cuckoo when they find it near their nests. But as individuals, they are afraid to approach too close to this hawklike bird, and so it is able to lay its egg in their nest.

The Hawk Cuckoo, *Cuculus sparveroides,* seventeen inches long, is an Indo-Malayan bird that closely parallels the appearance of a hawk. Its camouflage is so convincing that the first of these birds we collected was actually in our possession before we discovered its real identity. Even the behavior of this cuckoo is hawklike—it perches on exposed limbs and flies about with all the self-assurance of a hawk, instead of slinking through underbrush as do most other cuckoos. Briefly described, the hawk cuckoo is brown above, white below, with brown bars and a brown chest.

Some of the smaller cuckoos are brilliantly colored. Thus, the Violet Cuckoo, *Chalcites xanthorhynchus,* of the Philippines, is pure violet above with the entire under parts barred with black and white. Not a whit less striking is the metallic-glistening green Emerald Cuckoo of Africa. Among the larger parasitic cuckoos we find some that lay

their eggs in crow nests. The biggest of these birds, the Channel-bill, *Scythrops,* of the Australian region, is a gray bird the size of a raven. It has a very big bill.

MALCOHAS—BIRDS WITH GAUDY BILLS

Malcohas, which include some of the most beautiful cuckoos, are most abundant in the African and Indo-Malayan regions. All build nests and rear their own young. Malcohas have a thick bill, broad wings, strong legs, a long tail, and a rather clucking voice. We sometimes see them in tall trees, but these birds are really partial to undergrowth, bushes, and dense grass fields where they hop about energetically. Two of the most unusual kinds of malcohas dwell side by side on Luzon Island in the Philippines, where we have observed them. The Scale-feathered Cuckoo, *Phoenicophaeus cumingi,* is a long-tailed, bluish-black magpie-like bird. On examining one of these cuckoos closely, we found that the feathers of the head end in curly black vanes of cellophane-like texture. The Scarlet-eyebrowed Cuckoo, *Phoenicophaeus superciliosus,* a relative, has straggly red eyebrows and a pea-green bill.

The American Black-billed and Yellow-billed Cuckoos, *Coccyzus,* are cousins of the malcohas. Another near relative is the Squirrel-tailed Cuckoo, *Piaya cayana,* the most familiar cuckoo in South America (north to Mexico). Famous for its inquisitive personality, this denizen of the undergrowth and forest edge is reddish, with the head and neck more cinnamon; the ring around the eye is blood red and naked, the tail has broad white tips.

ANIS—THEY PREFER COMMUNAL LIVING

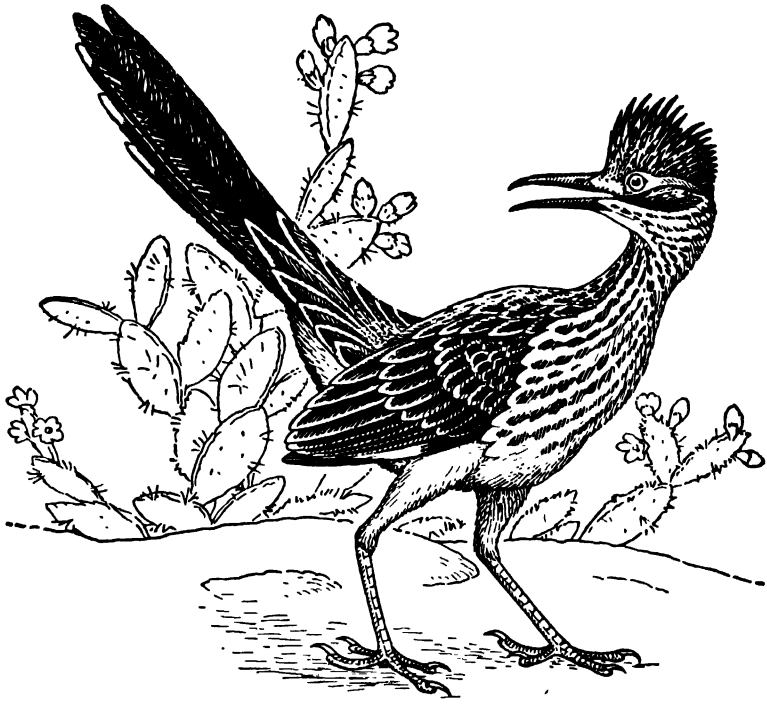
Anis are jay-sized cuckoos of South America, the West Indies, and tropical North America. They have high-pitched whining notes.

In Panama we were able to observe the Smooth-billed Ani, which favors grassy clearings and orchards, often near water. These birds have a marked taste for communal living. They usually travel in flocks of from six to fourteen birds. When approached, they flap slowly and clumsily from bush to bush. At night they roost in tight knots in high bushes. The birds build a communal nest in which the females deposit a number of eggs—twenty-six is the known

record—and incubate in a group. One nest we found was three feet up in a thick bush beside water. At the time of our discovery it contained two white eggs—later devoured by an iguana.

GROUND CUCKOOS

The Road Runner, *Geococcyx,* the best-known member of this group, dwells in the deserts of southwestern North America. It is a very unusual bird, with such nicknames as "snake-eater," "war bird," "cock-of-the-desert," and "lizard bird." This brownish cuckoo has a spotted crest, and its bright eyes give it an alert look. Its strong legs enable it to run like a deer, and for a goodly distance; it takes to flying only as a last resort.



THE "SNAKE-EATER"

This is one of the many names for the road runner, a cuckoo that is famous for its ability to kill rattlesnakes. The bird, which dwells in the American Southwest and Mexico, runs with dashing, headlong swiftness. The road runner's favorite food is lizards, but it also eats snails after smashing them against rocks.

The road runner's great claim to fame is its prowess in killing rattlesnakes. Apparently the rattler's venom, coils, and rattles hold no terrors for the road runner. The film *The Adventures of Chico* pictures the exciting duel between these two creatures and thus enables us to appreciate the remarkable deftness and uncanny timing of the road runner. Managing by rapid movements to stay just out of reach of the terrible fangs, the bird exasperates its opponent by stabbing it with its beak. The road runner approaches when the snake is uncoiled and hence not poised for a thrust; or the bird changes the direction of approach, causing the snake to turn laboriously. Finally, worn out by the struggle, the rattler admits defeat and tries to make off. The road runner, with victory in sight, seizes the snake at the back of the head, and shakes it and waves it viciously and pounds it on the ground. At last the snake is vanquished, and the road runner swallows it, starting with the head.

A road runner has been seen with part of a two-foot snake dangling from the bird's mouth. One observer reported seeing a road runner vanquish a rattlesnake three and one-half feet long. According to this account, the struggle ended when the bird punctured the rattler's brain by a powerful thrust of its beak through the snake's skull; the road runner, so we are told, ate the brain but drew the line at that point. There is a legend in the Southwest to the effect that the road runner makes a practice of building corrals of cactus spines around sleeping rattlers.

The road runner's favorite food is lizards, and it feeds small ones to its young almost right after hatching. Amusingly enough, the chicks eat the lizards head first, and it is not uncommon to see the tail of a lizard hanging out of the chick's mouth. The road runner is also fond of land snails; it smashes their shells against rocks by appropriate movements of its neck and beak.

The road runner builds a nest in a cactus bush and lays white eggs.

COUCALS—THROWBACKS TO A PAST AGE

The coucals of the Old World are very strange birds. There is something so primitive about them that they would not have appeared out of place in a Jurassic swamp with *Archaeopteryx,* some 125 million years ago.

In the typical coucal the claw of the hind toe is long and straight,

and the bill rather straight and thick; the legs are long and strong, the feathers of the head and chest stiff and pointed. The plumage is generally blackish, buffy, or brownish. Coucals rear their own young in a domed nest which has a side entrance and is always placed near the ground.

The Pheasant Coucal, *Centropus phasianinus*, of New Guinea and Australia, is larger than a crow but more slender. It has stiff, spiny feathers—in flight it is ungainly—but its long powerful legs are admirably suited for life on the ground. We often observed the pheasant coucal in kunai grass fields among bushes and boulders. It is a blackish-brown bird with narrow buff streaks and close reddish barring. When flushed from grass it often perches clumsily on low bushes, where, frequently, because of its ungainly proportions, it more resembles a dead limb than a bird.

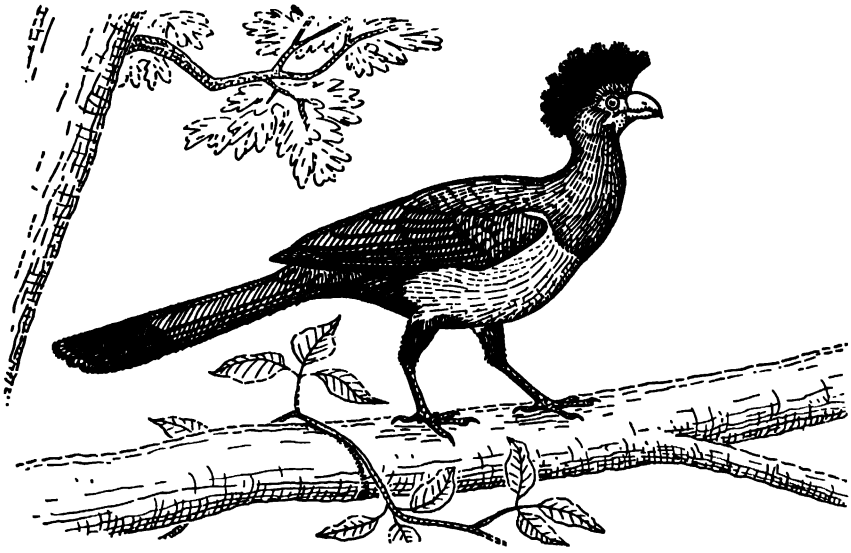
TURACOS OR PLANTAIN EATERS—BEAUTIFUL BIRDS OF AFRICA

Making their home only in Africa, the twenty or so kinds of turacos are among the most unusual and beautiful birds of that continent. Long-tailed birds of pigeon size or larger, turacos live entirely among trees, running along the limbs with all the agility of a squirrel. In the African forests where these birds are at home, the loud resonant calls of turacos are heard almost constantly. They feed chiefly on wild fruits, varying their fare with green leaves and an occasional snail or insect. The belief that these birds eat plantains (bananas) is apparently erroneous—hence the native name *turaco* is preferable to "plantain eaters."

The turaco's nest is a frail platform of sticks. The bird lays two or three white, bluish, or greenish eggs. Though naturalists usually place the turacos with the cuckoos in the order Cuculiformes, there are certain similarities between the turaco family (Musophagidae) and the gallinaceous (fowl-like) birds.

A typical turaco—the South African Lourie, *Turacus corythaix*, for example—has dense silky green plumage becoming glossy bluish on the wings and tail. A handsome, erect, white-bordered green crest adorns its head; the eye is set off by a circlet of white feathers. The wing quills are a deep rich maroon which we can see only when the bird is flying or spreading its wings. This brilliant color is produced

by turacin, a pigment that contains copper and is present in no other family of birds. Formerly naturalists believed that this red pigment, possessed by all but a very few turacos, was washed out by rain; but this seems to happen very rarely.



THE TURACO—A UNIQUE AFRICAN BIRD

Turacos are among Africa's loveliest birds. Many have wing feathers of a deep, rich maroon that is produced by a pigment known as "turacin." No other bird secretes this substance. As it runs along tree branches with all the agility of a squirrel, the turaco calls with loud, resonant notes. Shown here is the blue turaco.

The Violet Turaco, *Musophaga violacea,* lacks the harmonizing colors of the South African lourie. A purple, somewhat gaudy-looking bird, it has a maroon crest and the usual red wing patches. The large yellow bill extends onto the forehead as a bony casque.

An Abyssinian turaco, *Corythaixoides,* called the "Go-away Bird" from its note, is quite unlike other members of the family when it comes to color. Its back and breast are gray, the abdomen white, and the wing and tail feathers black banded with white.

By far the largest member of the family is the Blue Turaco, *Corytheola.* Some three feet long, it is one of the most conspicuous and noisy birds of the African forest, where it occurs in bands of half a dozen. When flying, it takes a few leisurely wingbeats and then

sails for some distance. It has blue plumage, washed with green on the breast and reddish on the abdomen. The large, pompon-like crest is black.

Owls—Creatures of the Night

SINCE FAR BACK in the dim past, men have associated the owl with the black arts, and with wisdom and grave learning. If you are familiar with some of the exquisite coins of the ancient Greek city-states, you have probably seen their representation of the goddess Athene and her owl. Just as Athene was the goddess of wisdom, the owl was the symbol of wisdom. To the Romans, who called this goddess Minerva, the owl was "Minerva's bird." In the Middle Ages there appeared in England an allegorical work, *The Owl and the Nightingale,* in which an owl, representing the clergy, debated with a nightingale, representing the nobility. Today the owl maintains its literary stronghold in "The Owl and the Pussycat." Yet there still remains an aura of mystery about the owl, even though we are aware that what once passed for inscrutability may be nothing more than lethargy.

To begin with, we are all familiar with the eerie sounds the owl utters—hoots, screeches, or wails, which may well have filled people of earlier times with a feeling of superstitious awe. This was all the more likely since owls are nighttime creatures—few of them hunt by day. Add to this the fact that owls are birds of prey, and grimly efficient ones at that. For a long time naturalists associated the owls with the hawks, but the experts came to realize that the resemblance between these birds extends only to their fitness for preying on other birds and small mammals. Actually owls (they make up the order Strigiformes) are related to that other group of nighttime birds, the queerly named nightjars or goatsuckers.

POWERFUL BIRDS OF PREY

As birds of prey, owls have one great advantage over hawks. Where these latter swoop down with noisy whirrs of their powerful pinions, the owls make the same deadly descent in complete silence, as their feathers are fringed with down. No wonder the owl is sure death for rodents, shrews, and other small mammals that are abroad at night. From man's point of view, owls are among the most valuable of all our birds, for they are famous destroyers of harmful rodents and insects. When devouring a victim, owls generally swallow mice or other small prey whole. In due course they regurgitate fur and indigestible bones in the form of pellets. These are sometimes found in large numbers at owl roosts and, when studied carefully, they yield valuable information about what owls feed on.

Since the owl is active at night and since it is a bird of prey, you would not expect its plumage to be bright—and it isn't. But whatever owls lack in the way of brilliant coloring, they make up for it in subtle shading and intricacy of feather pattern. Their eyes, too, are adapted for nightlife and stealthy prowling. Their eyes are very large—one of the features that give owls an "owlish" appearance—to enable them to make the most of the weak light available at night.

Owls also differ from most birds in that both their eyes face forward, giving them binocular vision; other birds must scrutinize an object with only one eye at a time. The owl seems to enjoy an advantage, too, as regards hearing. Although no birds have a true external ear, the feathers surrounding the ear openings of owls are often thin and bristle-like—perhaps to permit better penetration by sound waves. We find also that in some owls the ear openings themselves are much larger than in other birds.

As we have noted in the case of many birds of prey, the female owl is larger than her mate. Most owls nest in hollow trees or other natural cavities and lay white eggs. These eggs are rounder than most birds'—probably an adaptation that makes it easier for the incubating bird to turn the eggs in such close quarters as are provided in a tree cavity. Some owls, you may recall, are pugnacious enough to usurp the nest of an eagle. They sometimes mete out the same disrespectful treatment to a crow or hawk. Young owls are covered with down, and grow rather slowly to maturity despite their tremendous appetites.

SCREECH OWLS

The Screech Owl, *Otus asio,* is perhaps the most familiar owl in North America. A small bird with a maximum length of ten inches or so, it has a characteristic melancholy cry that accounts for its name. We encounter the screech owl wherever it has managed to find a hollow tree—even in a village—that affords it refuge during the day and a place to nest. Like many other owls, the screech owl has two earlike tufts of feathers on its forehead. This bird has two color varieties—some individuals are gray, others reddish brown. These color distinctions have nothing to do with sex or age—you may find gray and brown young in a single brood.

GREAT HORNED OWLS—FIERCE YET WARY BIRDS

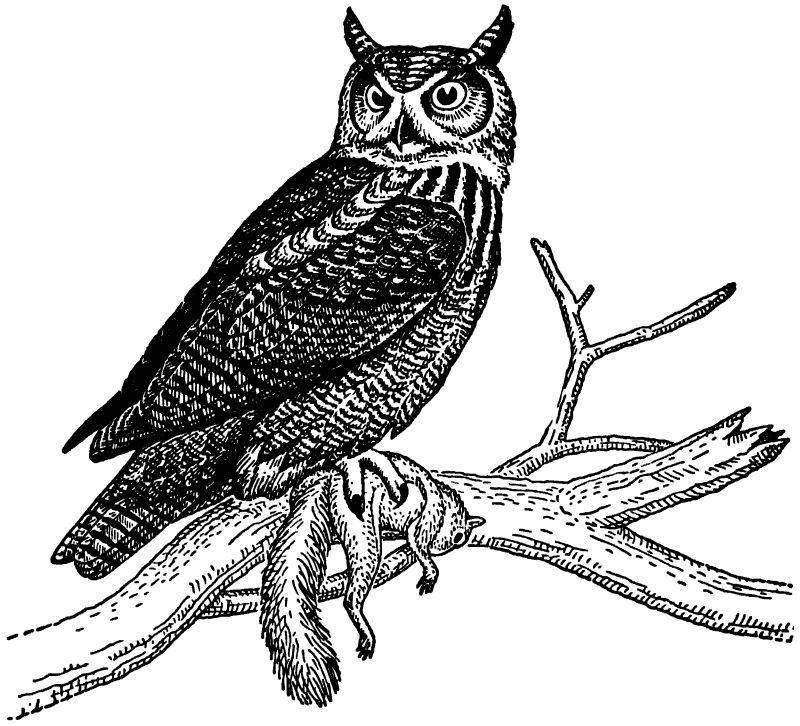
The Great Horned Owl, *Bubo virginianus,* is sometimes dubbed the "tiger" of the bird world. The most powerful of all the owls, it is also one of the largest, with a length of twenty-three inches or thereabouts. Aside from the absence of the reddish-brown coloring, the great horned owl might pass for a giant-size version of the screech owl. Feeding on rabbits, rats, and almost any other medium-sized prey it can find, this ferocious owl disposes every now and then of a domestic cat, a hen, or a skunk. It has been known to seize turkeys on their night roost and to drive off eagles. Its bill is powerful, its feet like grappling hooks.

This owl has just the kind of very fierce disposition that we associate with birds of prey. Its young, even when taken from the nest at an early age, usually prove vicious and intractable. As with most owls, the female is considerably larger than her mate. Her hooting differs in pitch from the male's, so that you can distinguish the pair as they answer one another.

For all its great size and sometimes destructive food habits, the great horned owl is a wary creature. Holding its own better than most owls, it is a long-lived bird, and one great horned owl reached the age of sixty-eight years in a zoo. Of course, such an age is not indicative for life in the wild. Still, as you might expect from these traits, this owl is very adaptable, and gets along just as well in the deserts of Arizona as in the great Canadian forests. Like most other

owls, it does not migrate; it does happen occasionally that some individuals move south when faced with a shortage of food.

In Europe and Asia we find a cousin of the great horned owl, but even larger—the Eagle Owl, *Bubo maximus* ("the biggest"). Other species make their home in India and Africa.

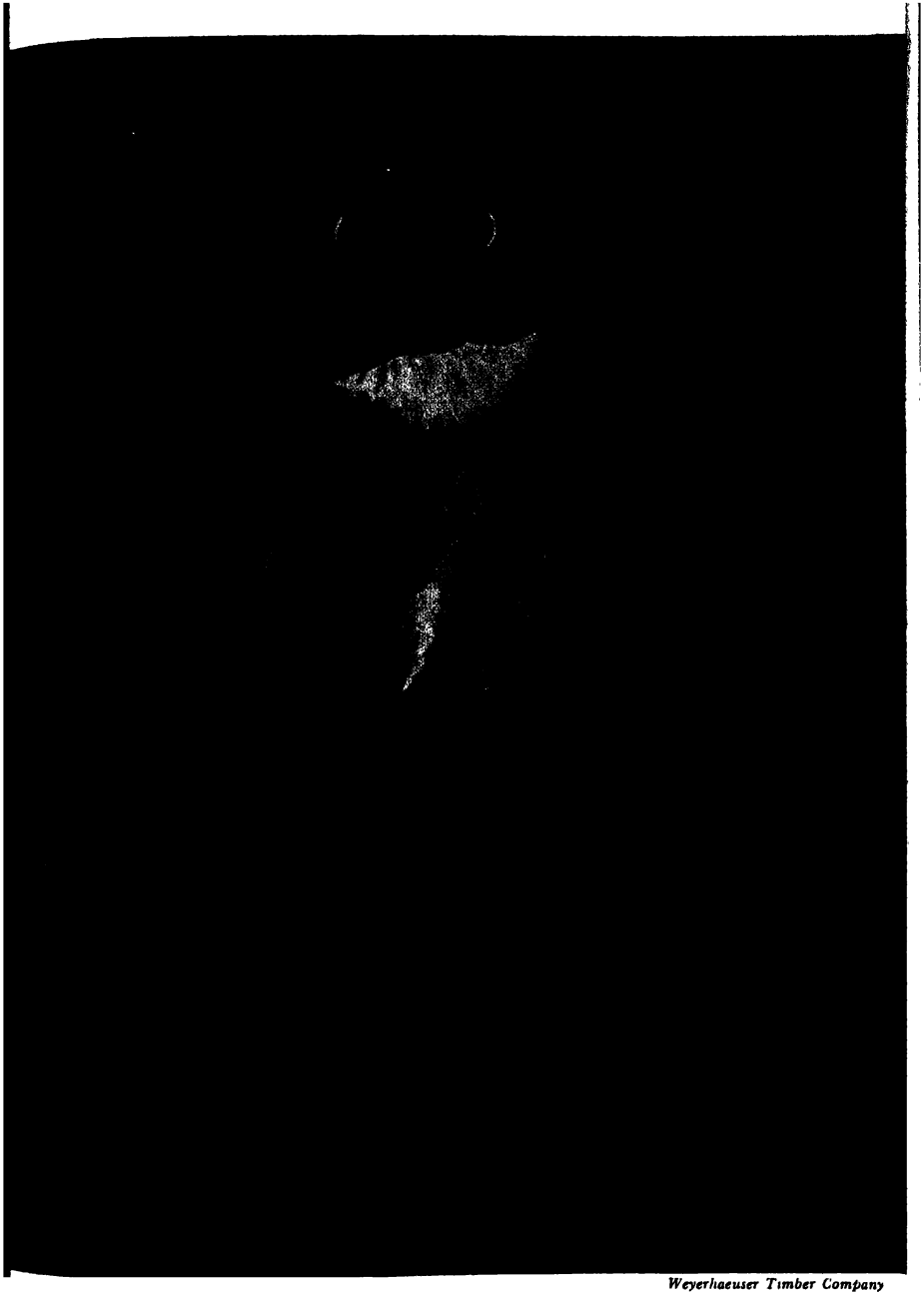


A FIERCE BIRD OF PREY

The great horned owl is so fierce that it has been known to drive eagles from their nests. Preying on fowl and small mammals, it seizes them with talons that have been likened to grappling hooks. Like other owls, it is able to descend in absolute silence on its victims because its downy plumage muffles any sound that might be produced in flight. A long-lived bird, the great horned owl is highly adaptable to extremes of climate.

BARRED OWLS—CANNIBALS ON OCCASION

The Barred Owl, *Strix varia,* feeds chiefly on mice, frogs, and similar small prey. Not infrequently it makes a meal of its smaller cousin the screech owl. You can readily distinguish the barred owl's hoot, which ends in a wailing squall. This owl does not have ear tufts, and it also



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THE GREAT HORNED OWL, TERROR OF THE NIGHT

The great horned owl is the fiercest and one of the largest of its family. It is a rough-and-ready sort of bird, able to live in all types of country, from dense forest to barren desert, provided there is food enough to satisfy its voracious appetite. Rabbits, skunks, mice, birds, and even large insects contribute to its bill of fare. In the winter the great horned owl migrates south.

differs from most other owls in having brown—not yellow—eyes. Widely distributed throughout eastern North America, the barred owl has a cousin, the Spotted Owl, *Strix maculosa,* a rare bird found locally on the Pacific seaboard.

Another cousin of the barred owl is the Great Gray Owl or Lapland Owl, *Strix nebulosa,* which dwells in the heavy cone-bearing forests of the Northern Hemisphere, and occasionally as far south as Maine. Although it is a beautiful owl and very large—about thirty-three inches long—it is actually a huge ball of feathers, quite inferior to the great horned owl in strength and weight.

SNOWY OWLS OF THE ARCTIC

The Snowy Owl or White Owl, *Nyctea scandiaca,* is well known to us, if only in pictures. It is one of the few owls that hunt by day—it has no choice during the long Arctic summer on the tundras where it nests. Normally it feeds on lemmings and on arctic hares and grouse. To withstand the rigors of the northern winter, this owl of the Arctic is densely clad in feathers right down to its toes.

SHORT-EARED OWLS—THEY MIGRATE MORE THAN MOST

As we have seen, owls are not much given to migrating. The Short-eared Owl, *Asio flammeus,* is an exception. Perhaps because of its willingness to undertake long flights it was able to establish itself even in the Hawaiian Islands. This owl lives mainly in marshes or wasteland, and mice are its favorite food. It lays five or six eggs and, like most owls, begins incubating as soon as the first egg is laid. The result is that the young hatch out over a period of several days and vary quite a bit in size and development.

ELF OWLS OF THE DESERT

Some species of owls are no bigger than a sparrow; one of the most interesting of these is the cute little Elf Owl, *Micrathene whitneyi,* no more than six inches long. Dwelling in the American Southwest, it usually sets up housekeeping in a giant cactus. Often you may see its round little head as it peers about in the entrance to its home. Like

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most small owls, the elf owl lives mainly on insects. Each pair seem to have their own hunting territory, and a resident owl will be quick to challenge an intruder if he whistles an imitation of its notes.

BARN OWLS–PARTICULARLY USEFUL TO MAN

The Barn Owl, *Tyto alba,* devours tremendous numbers of rats and mice. This voracious appetite is a boon so far as man is concerned. About eighteen inches long, the bird has such a queer appearance that it is known as the Monkey-faced Owl in many parts of the United States. Look at the owl closely and you will see that its plumage reveals beautifully mottled shades of buff and brown.

A greedy eater, as we have noted, the barn owl is admirably equipped for keeping itself well fed. The tendons of its legs, as in other birds of prey, are attached to the bones in such a way that they automatically close the claws in a tight grip when the leg is bent. And so, as the bird makes contact with its prey after swooping down with legs outstretched, its weight causes its legs to bend, whereupon the talons tighten and pierce the vitals of the unfortunate rat or mouse. This adaptation is merely a further refinement of one found in many birds which makes it possible for them to automatically grasp a perch while sleeping at night.

Though partial to warmer regions, the barn owl is one of the most cosmopolitan of birds and is found throughout the world—even such out-of-the-way spots as the Fiji Islands. These owls frequently make their homes in church steeples, towers, or barns; many, however, still prefer hollow trees. The barn owls have cousins in the Old World, particularly in the Australian region. They all share with the common barn owl certain peculiarities of body structure that may justify naturalists in placing them in a family distinct from the other owls

Goatsuckers and Their Relatives

IN THIS GROUP we find some queer birds—and queerer names. Goatsuckers do not suck the milk of goats. Nighthawks are not hawks and are fairly active in the daytime. Whippoorwills are named after their famous cry, as are chuck-will's-widows. Nightjars are named for the curious jarring quality of their notes. The potoos and frogmouths are chiefly remarkable for their wide, capacious mouths. Oilbirds, once valuable for their body grease, live a batlike existence. Strangest of all the members of this order (the Caprimulgiformes) is the Poorwill, the only bird definitely known to hibernate!

GOATSUCKERS OR NIGHTJARS—THE BIGMOUTHS

Where does the name "goatsuckers" come from? It seems to date back to Aristotle's statement that these birds use their huge mouths to suck milk from goats. There is no basis whatever for this belief —the true function of this wide gap is to engulf night-flying insects. In fact, it is not uncommon for one of these birds to fly, mouth agape, right into a swarm of insects. Large bristles extending from the corners of the mouth help rake them in.

A better name for the seventy species of this family (the Caprimulgidae) is "nightjars." The word "jar" derives here from the "jarring" notes—akin to the churring of a wheel—of the European Nightjar, *Caprimulgus europaeus.* Several American goatsuckers also have names that are really renderings of their loud calls. Among these are the Poorwill, *Phalaenoptilus nuttalli,* and, as we have seen, the Whippoorwill, *Caprimulgus vociferus,* and the Chuck-will's-widow, *Caprimulgus carolinus.*

Like the owls, to whom they are related, nightjars are usually

active only at night, spending the day perched unobtrusively on the ground or on the limb of a tree. Their feet are weak—so much so that they usually lie lengthwise on a limb for added support. Nightjars often make good use of protective coloration. Their plumage, for example, has a beautifully intricate and blending pattern which camouflages them to perfection when they are at rest.

NIGHTHAWKS—FINE FLIERS BUT NOT HAWKS

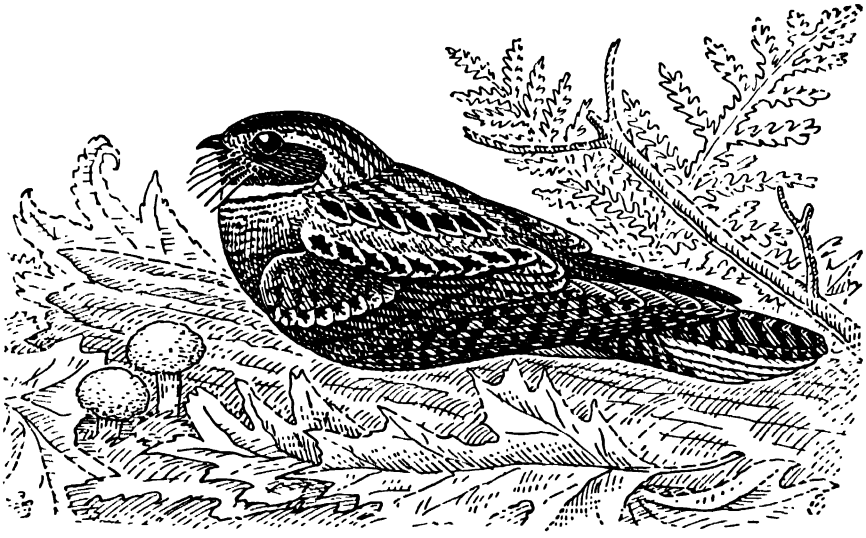
The Nighthawk, *Chordeiles minor,* despite its name, has no relation to the true hawks. Unlike most of its cousins, it is partial to open country and is often active by day as well as by night. For these reasons, and also because it is the most generally distributed of the tribe, it is the best known of American nightjars. With a wingspread of about eighteen inches, it is a conspicuous bird as it swoops tirelessly, albeit somewhat erratically, through the air—usually at a considerable elevation. At courtship time the male attracts attention by a spectacular dive earthward—then checking its descent so quickly that the rush of air through its wing quills produces a loud booming noise. The nighthawk's long narrow wings are marked with a white spot. Its characteristic call is a loud, nasal *peent.*

Like most of its fellow nightjars, the nighthawk does not bother to build a nest; it simply lays its two eggs directly on the ground in a rocky or gravel-covered spot. Mottled with gray, the eggs are hard to see. Later on, the downy young also match their surroundings closely. One of the most remarkable traits of nighthawks is their habit of laying their eggs on the gravel-covered flat roofs of city buildings. This has advantages, if only to keep the eggs safe from such marauders as egg-eating snakes. If undisturbed by man, the birds frequently succeed in raising their young on top of the buildings.

Nightjars live almost entirely upon flying insects and, as you might expect, the members of the family that normally dwell in temperate regions migrate to the tropics with the coming of cold weather. This of course applies to the nighthawk, and you may sometimes see vast numbers of them heading south by day—though the other kinds travel by night. In the latter event, the birds rest during the day, waiting for the approach of twilight, when they can devour the insects that appear in full force at that time.

TWO NIGHT BIRDS AND A HIBERNATING BIRD

The shy whippoorwill is the best known bird of the night in many forested parts of the United States. Though it is rarely seen—except as a shadow flitting through the twilight—its presence is immediately revealed to you by its loud cries. Over and over again it utters its call with breathless haste. On one occasion John Burroughs counted no less than 390 consecutive calls by one bird. The whippoorwill puts its nocturnal wanderings to good use—it is a great insect-destroyer. Its cousin the chuck-will's-widow is an equally noisy bird, though it favors more southerly regions. About the size of a pigeon, the "widow" has such a wide mouth that it sometimes swallows warblers, sparrows, and other small birds at night, doubtless mistaking them for insects.



A NIGHT BIRD NAMED FOR ITS FAMOUS CALL

Heard but not seen, the whippoorwill is famous for its characteristic call in the night. It repeats this call over and over—a naturalist counted some four hundred consecutive calls. The whippoorwill eats great quantities of insects during its nightly wanderings.

Naturalists made one of the most remarkable discoveries of recent years when they verified that the poorwill, which dwells in western North America, sometimes spends the winter in hibernation. For three successive winters they found one of these birds in the same

rocky niche on a canyon wall in the Chuckawalla Mountains of California. During the hibernating period they were able to handle it freely without disturbing it—even the beam of a small flashlight failed to evoke a response when shone directly into its half-open eyes. Their astonishment at its torpid behavior faded when they found that this poorwill's temperature was in the neighborhood of 65° Fahrenheit. As we have seen earlier, slightly over 100° is normal for birds.

POTOOS—THEIR MOUTHS CAN CLOSE OVER A TENNIS BALL

The Giant Potoos or Wood Nightjars of the New World tropics are owl-like birds of the night with mouths huge enough to be capable of closing over a tennis ball.

Potoos may sometimes be seen at dusk gliding over grassy savannas but it is more usual to find them after dark when their large bulging eyes cast golden reflections in the beam of a torch. In our wanderings at night we have come on solitary birds perched on a fence post or on a rock outcropping in a forest clearing. In Panama we heard the mournful wail, "Poor—me—one" of a potoo (*Nyctibius griseus*) almost every night of the dry season. After dark, potoos foray out flycatcher-like from selected perches in quest of large night-flying insects. The potoos are grouped in the family Nyctibiidae.

The potoo's nest is a slight hollow on the top of a post or in the side of a decaying tree, anywhere from four to twenty feet above the ground. Here the female deposits a single white egg marked with violet and brown. It takes some seventy days to incubate the eggs and care for the young. The way the incubating adult projects from the sides of the nest stub makes the bird appear to be merely an extension of the limb or post.

The Great Potoo, *Nyctibius grandis,* of tropical America, is about the size of a large slender owl. Its plumage is marked with wavy dark brown lines, the abdomen is whitish. The downy, barred young is most remarkable, its broad head resembling a puppy's.

OILBIRDS—CAVE DWELLERS BY DAY

The oilbird or guacharo is a curious bird which makes up a family all by itself, though in some ways it is like the owls and goatsuckers. Oil-

birds live in huge colonies in tropical countries, clustering like bats in dark cave recesses by day and foraging far afield at night in great, croaking flocks in search of fruit. They are much sought after by the natives, who provide themselves with illumination and a butter-substitute by killing the birds and melting them down for their body grease.

The oilbird is the only member of the family Steatornithidae. It was the famous naturalist Alexander von Humboldt who discovered this bird in Venezuelan coastal caves in 1799 on a scientific expedition with Aimée Bonpland. More recently, naturalists have come across the birds in isolated caves on Trinidad, in the Guianas, and in the Andes of Colombia, Ecuador, and Peru.

About eighteen inches long, the oilbird has reddish-brown plumage, with oval whitish spots on its wings. Its sharply hooked bill is ringed with stiff bristles. The oilbird builds a platform of dried mud for its nest, and lays two to four white eggs which are spotted with reddish brown.

OWLET FROGMOUTHS

We find the few species of owlet frogmouths in Australia and New Guinea. Making up the family Aegothelidae, they nest in hollow trees and sit upright like owls—traits that place them between the owls and the more typical nightjars or goatsuckers.

FROGMOUTHS—THEY HAVE AN ENORMOUS GAPE

Frogmouths, as we have seen, get their common name from their enormous gape. The resemblance to a frog is enhanced by the broad, flat bill. Rather sluggish, inactive birds, they hop about among tree limbs seizing moths or large insects, instead of feeding on the wing like most of their relatives. There are a dozen species of frogmouths, grouped in the family Podargidae, and they make their home in the Oriental and Australian areas of the Old World tropics.

Some frogmouths are as large as a good-sized owl, and they are akin to owls in their habit of sleeping upright on a tree limb during the day. Frogmouths are also about the size of the potoos of the American tropics, and somewhat similar to them in appearance. Unlike other nightjars, the frogmouths build a nest of twigs in a tree. It is a flimsy structure, barely sturdy enough to support the eggs and young.

Swifts and Hummingbirds

THESE ARE among the smallest birds, and also among the most remarkable. Some of the swifts are generally accorded the distinction of being the fastest of all flying birds, while the hummingbirds have so many entrancing aspects that it would not be easy to single out one special feature. What is most astonishing about them, perhaps, is the endless variety of their lovely color schemes. The classification of the swifts and hummingbirds has been a matter of much discussion among naturalists. In this book these birds are grouped in the order Apodiformes.

SWIFTS—THE MOST ENERGETIC OF ALL THE BIRDS

Swifts are just that: swift. About five inches long on the average, these small birds are capable of fifty-five miles an hour—and more. Naturalists believe that the larger swifts are the fastest fliers of all the birds, rivaled only by some of the bigger falcons. Living in groups, many of the seventy-eight species of swifts—all told, they make up the family Apodidae—travel in droves that spiral skillfully across the horizon. Their flight is jerky, interspersed with long glides, and they often indulge in such aerial antics as changing formation in midair. Fleet of wing as they are and seemingly tireless, swifts are the most energetic of all birds on the wing.

Do not think, however, that the swift's extraordinary flying abilities are its chief claim to fame. It is unique among birds because it never perches on horizontal surfaces. The swift's feet are too weak to support the weight of its body. Swifts, then, are able to rest only when they are clinging to vertical surfaces. Away from these, all their contacts with food, drink, and with each other must necessarily be made while in full flight! Living on insects which they catch on the

wing--naturally—swifts suffer grievously in periods of prolonged storms when flying insects are not available. Both young and adult swifts have been known to perish in great numbers at such times.

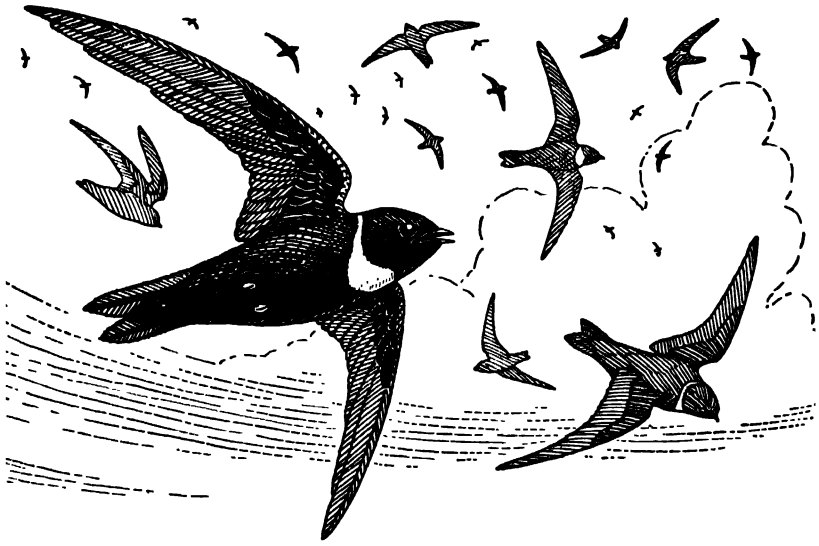
Even when swifts gather nesting material, they assemble it on the wing. They snatch floating plant cotton from the air or else they tear or break free bits of grass or twigs as they fly past. Thus, the familiar Chimney Swift, *Chaetura pelagica,* of North America, grabs brittle twigs with its tiny feet while in full flight. Often a bird attacks a single twig repeatedly until it finally succeeds in breaking it loose. Then it glues the material to a vertical surface in some dark spot—usually the inside of an unused chimney or a hollow tree. The half-saucer nest may be near the top or as much as twenty feet deep in the cavity. The chimney swift has sharp claws and spiny tail feathers to help it cling to the interior of a tree or chimney.

Swifts live all over the world, and those of the temperate zones are migratory. They range from the size of small swallows (with which they are often confused) to that of a small falcon. The swift has a very small bill, but the broad gape is effectively adapted for engulfing flying insects. The large salivary glands produce an exceptionally sticky saliva used in nest-building. Robust and streamlined, the swift's body is cloaked with hard, glossy, greenish-black or dark-brown plumage. A few species have brighter feathers—chestnut or white collars, for example. Without exception the female resembles the male and the young assume the adult plumage as soon as they shed their down.

The famous Chinese penchant for "bird's nest soup," of which you have probably heard, had its origin in the nesting habits of the little cave-swiftlets of the Indo-Australian region. Perhaps the most peculiar of all swifts, these birds like to live in colonies, and they all use glutinous saliva in constructing their nests; at least one, *Collocalia inexpectata,* fashions the entire basket with it. This is how the Chinese harvest the nests: Shortly before the breeding season starts, they sweep out all the old nests from the cave walls. As soon as new nests have been constructed, they are harvested. This may be done repeatedly in the early stage of the breeding season, but in due course the swifts are allowed to breed in peace. Thus, the colony is not depleted. As with all swifts, the eggs are pure white and oval shaped, and the young are born naked.

The swift has a high-pitched, twittering voice; some species are

very shrill. The Collared Swift of Central and South America, *Streptoprocne zonaris,* can be heard a hundred yards away when the wind is right. We were once attracted by the strange calls of these birds to a waterfall situated four thousand feet up in a spur of the eastern Andes of Colombia. As we watched at dusk, we saw collared swifts fly through the spray at the edge of the falls and disappear behind them. Famous for their habit of roosting and nesting under roaring waterfalls, the collared swifts have a wingspread of eighteen inches and are blackish except for a prominent white collar.



FAST AND NOISY

The collared swift is one of the largest of all the swifts—birds credited with being the fastest fliers of all. It is seen in flocks near waterfalls. Under the right conditions its shrill voice carries about a hundred yards. Note the conspicuous white collar.

Familiar as the chimney swift is to us, it remained until recently one of the great mysteries of nature. Literally millions of these birds enter and leave North America every year. So large are these migrating flocks that thousands of the birds have been trapped in a single night for banding and study. Yet, until recently they disappeared across our southern borders—not to be seen until spring, when, invariably, they winged their way northward right on schedule. At last, chimney-dwelling swifts were observed on the middle Amazon in March and some of them were seen in upper Amazonia. Thus nat-

uralists have at least partially solved the mystery of the chimney swift's winter quarters.

CRESTED, OR TREE, SWIFTS

Tree swifts differ from true swifts in a number of ways. The chief distinction is that their legs are much larger and stronger, enabling them to perch like normal birds. What confirms the tree swifts' kinship to the swifts is their habit of glueing their small cup-shaped nest to its anchorage on the side of a limb high on a forest tree and then securing the single egg to the inside of the nest with saliva.

The three species of tree swifts—they compose the family Hemiprocnidae—range from India and the Philippines to the Solomon Islands. They include the Whiskered Tree Swift, *Hemiprocne mystacea,* of Malaya and the Australian region. Fully a foot long, this bird has long narrow wings and a long but very slender forked tail. Its head is black, with lines of projecting white feathers on the face—hence the name "whiskered."

In New Guinea we occasionally found small parties of these birds in the deep forest. Again and again they would return to their high perches, even after being scared off by gunfire.

HUMMINGBIRDS—INCREDIBLY SMALL, INCREDIBLY BEAUTIFUL

Hummingbirds are so beautiful that in the opinion of some naturalists they surpass even the peacock and bird of paradise in loveliness of appearance. Whether or not you share that view, you will find that these "glittering gems" of the bird world are truly among Nature's wonders. The smallest hummingbird, about two inches long and weighing in the neighborhood of one-tenth of an ounce, is the smallest of all feathered creatures. It lays two unbelievably tiny white eggs in a nest no bigger than a walnut shell. Even the Giant Hummingbird is only a "giant" by comparison, with its mere nine-inch length.

Yet this little bird is admirably equipped for superbly precise flying. Its name gives you a hint of its prowess—the wings move so rapidly that they produce a whirring sound; and their motion, as far as our vision is concerned, is nothing but a blur. The whirring is most noticeable when hummers hover to feed on nectar-laden flowers. At

such times, the bird's wingbeats are about fifty-five to the second, and to photograph it you need an exposure of no more than one five-thousandth of a second.

Some hummingbirds make fairly long migrations, partly nonstop as when they cross bodies of water. Yet it is in brief flights that they are outstanding—perhaps the fastest flying birds on short hauls. Many species are capable of such remarkably swift movements that their darting flight reminds us of the passage of an arrow through the air. One moment the hummingbird is hovering close to the ground, hanging over a favorite flower extracting the sweet contents; the next moment it shoots to the very summit of a lofty tree—as if launched from a bow.

Of all the birds, only the hummingbird is capable of true backward flight. Its aerial maneuvering is remarkably similar to that employed by the modern twin-'coptered multi-place helicopters. However, while the twin blades of the man-made machine travel in horizontal paths, the wings of the hummingbird describe oval circles diagonal to the ground.

Hummingbirds dwell only in the Americas. We may find them at sea level or at an altitude of sixteen thousand feet in the equatorial Andes; some live near Cape Horn, others in Alaska. Certain species, as we have seen, are migrators. This is chiefly true of hummers in the temperate zones; the Ruby-throated Hummingbird, *Archilochus colubris*, of eastern North America, winters south to Panama. Still, others spend their whole lives in narrow floral belts hardly more than a few hundred yards in width; many are as effectively "rooted" as plants to the confines of a single mountain peak or little island.

It is in the subtropical zone of Colombia and Ecuador that hummingbirds are most plentiful. Of the 319 known species—all told, they make up the family Trochilidae—no less than 133 make their home in Colombia. Though we find eighteen species in the United States, only eight of these appear any distance to speak of from the Mexican border. In fact, only one, the ruby-throat, appears regularly east of the Mississippi.

The hummingbird's legs are weak and delicate. The wings are very strong in comparison—just what you would expect of a bird that spends most of its active hours aloft, feeding entirely on the wing with the aid of its highly specialized bill. There are cases where specialization reaches such a point of refinement that the bill is a good

five inches long and is used with only one type of flower. Generally the bill has a slight downward curve and a sharp point; but in some cases it is nearly straight and in others it describes a circle-like curve.

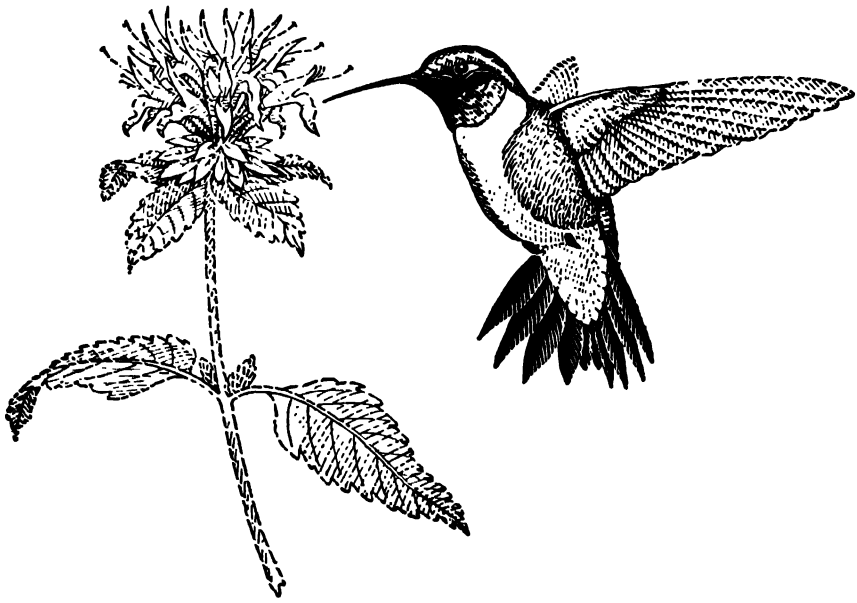
To get at its favorite nectar, the hummingbird has developed a specialized tongue too; in fact, it is complex to a point matched by no other bird's tongue. The outer part of this tongue is rolled or tubular. At the throat it is linked to a fork in the hyoid (tongue) bones. The prongs of these bones pass under the throat and around the skull to anchorages on the forehead. With this extraordinary apparatus it becomes possible to take up the immense recoil of the long tongue; and so the hummingbird is able to reach deep into the innermost recesses of certain flowers and to extract nectar, tiny insects, and spiders. Because of their specialized feeding habits, hummingbirds are important pollinators of flowers—almost the only birds in the New World that play this typical insect-role.

Hummingbirds are active during the day, though it is true that we see many species only at dawn and dusk. And there are many others that live in twilight deep in the cathedral forests of the tropics, while still others dwell in the tops of the trees where they are even harder to discover. However, most of them are found in savannas of the lowlands and along the edge of open forests in areas where flowers are plentiful. In such places we are apt to find great numbers of hummingbirds together, creating the deceptive impression of a taste for group living. They have no flair for song, their best effort being a feeble cheep or squeak.

These birds are surprisingly fearless as far as man is concerned, and will readily venture in his presence. They are equally unafraid in facing any creature that approaches their nest. As for their methods of nest-building, the technique of the ruby-throated hummingbird is typical for the group. It fashions its nest of plant cotton and decorates it with lichens laced together with spider webs, usually saddling the structure on a small limb about twenty feet above the ground. It lays two tiny white eggs—this is true of the whole tribe. It takes about two weeks to hatch the young, blind and naked—yet in another three weeks they are feathered and ready to leave the nest. During the final days in the nest they grip the edge with their feet and flutter their wings to strengthen them for flight.

At courting time, male hummingbirds zoom through the air in spectacular dives. After mating, the females usually take on the whole re-

sponsibility for nest-building, incubating, and caring for the young. Some kinds of male hummers do, it is claimed, take an interest in family affairs. The females are efficient mothers. For example, the female Black-chinned Hummingbird, *Archilochus alexandrae,* gets no assistance from her mate. Yet she has been observed building a second nest and laying eggs in it, while she is still feeding her first pair in their nest.



THE ONLY HUMMINGBIRD OF EASTERN NORTH AMERICA

Hummingbirds generally live in the tropics. The only "hummer" that ventures into eastern North America is the ruby-throated hummingbird. The brilliant ruby throat is possessed only by the mature male. The female and young are green and white. This hummingbird is said to be capable of a flight speed of fifty-five miles per hour.

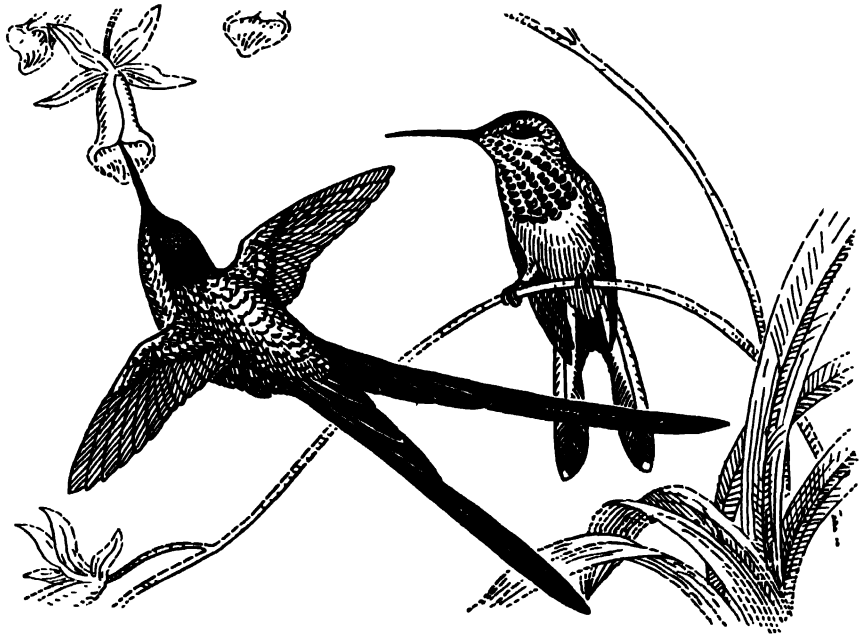
The young are fed by regurgitation. It is astonishing to watch the parent's seeming ferocity and the depth to which the needle-like bill is driven into the baby's throat.

Of the many remarkable characteristics shared by hummingbirds, probably the most striking of all is the glittering metallic or iridescent plumage of the males. Another important feature, though not so well known to most of us, is the leathery texture and strength of the skin.

Rarely found in any birds, this texture is all the more surprising in these diminutive creatures.

The Ruby-throated Hummingbird, *Archilochus colubris,* is a familiar bird in eastern North America. It is named for the adult male's sparkling, iridescent ruby-red throat. The upper parts are shining green, the wings and tail have a dark purplish cast, while the under parts are dull gray. In females and wintering males the lovely ruby-red color is lacking. Sometimes, after a sapsucker has bored a hole in the trunk of a maple tree, one of these birds will insert its tubular tongue in the hole to suck out the sap. Ruby-throats nest from central Canada south to Florida and as far west as North Dakota.

Gould's Hummingbird, *Hylonympha macrocerca,* one of the largest members of the family, was the subject of an intensive search by collectors for over seventy years. Described from a trade skin in 1873, and well represented in collections received that year by European



AN ELUSIVE HUMMINGBIRD

It took naturalists seventy-five years of intensive search to find the home of Gould's hummingbird, one of the most famous of these small birds. Hummingbirds are noted for their gorgeous colors, swift, perfectly controlled flight, and ability to fly backwards.

feather merchants, this hummingbird thereupon vanished into the blue. In the following years naturalists conjectured and explored extensively for this great rarity—all to no avail. It was not until 1947 that Dr. W. H. Phelps of Venezuela solved the mystery by rediscovering the bird on Cerro Azul in eastern Venezuela. Another collector had spent time halfway up this mountain without finding a trace of the hummingbird—yet in the restricted summit forest, hardly thirty miles away from busy Port-of-Spain, the bird proved abundant.

About eight inches in total length, Gould's hummingbird has a scissor-like tail that reaches a length of almost five inches. Males are glossy green, with velvet-black hind crown, upper back and tail. The forehead is sparkling violet, the under parts dull green.

The Bee Hummingbird, *Calypte helenae,* of Cuba and the Isle of Pines, is not only the smallest hummingbird but also the smallest feathered creature in the world. Rather rare, this tiny bird is a cousin of the much larger ruby-throat of eastern North America. Its common name aptly describes its size and general appearance in flight. The total length is something over two inches—rather large for a "bee," but more than half of this length consists of the bill and tail. The male is bright ruby on the crown, throat, and long ear tufts, with bluish-green upper parts, a still more bluish tail, and dull-gray underparts. The female looks like the male, except that the ruby coloring is replaced by green above and gray below.

The Giant Hummingbird, *Patagona gigas,* of the Andes, is over eight inches long and is by far the largest of the hummingbirds. This estimate is based chiefly on weight, for a few of the slender-tailed species slightly exceed it in total length. These giant hummers are reported to feed occasionally on smaller species of hummingbirds—a most unexpected example of cannibalism, and one that still arouses skepticism.

OTHER SPECTACULAR HUMMINGBIRDS

To describe the endless variety of hummingbirds, each one more beautiful than the next, we would need a whole volume. So, we can mention only a few of them, and the salient characteristics by which they may be known. Even their common names, you will note, reflect the admiration of the naturalists who described them.

The Collared Inca, *Coeligena torquata,* of Central America, is a large blackish hummer with white chest and tail. The Guatemalan Hermit, like all members of its genus, has a greatly elongated central pair of tail feathers, tipped with white. The minute White-footed Racket-Tail, *Ocreatus underwoodi,* of Venezuela and nearby countries, is green with a needle-like bill, white thighs, and two long tail-wires tipped with tiny black flags. The Frilled Coquette, *Lophornis magnifica,* of Brazil, is perhaps the most highly adorned of small hummers with its pointed cinnamon crest, green throat, extensible white neck-fans tipped with green and black, and bronzy-green body, brownish tail, green forehead, and straight coral red bill! Anna's Hummer, *Calypte anna,* a Californian species, has a greenish bronze back, while the throat and sides of the neck are gleaming ruby red.

Another spectacular member of this numerous family is the Sappho Comet, *Sappho sparganura,* of the southern Andes, a gorgeous scissor-tailed bird fully seven inches long. Its back is deep rose, the wing and head glistening green, and the fantastic streaming tail bright bronze. The emphasis is all in the opposite direction in the case of the Sword-billed Hummer, *Ensifera ensifera,* of the high Andes, which is dark green with a perfectly incredible bill that quite overbalances the rest of the body. The tiny, rose-colored Snow-cap, *Microchera,* is a straight-billed hummer with a prominent white cap. The Heavenly Sylph, *Aglacocercus coelestis,* has tremendously elongated violet-blue scissor-like tail feathers, giving it a total length of nine inches. The Helmet-Crest, *Oxypogon guerini,* of the Andes, is amusingly decorated with a long white beard and white and black crown plumes. Gould's Sickle-bill, *Eutoxeras aquila,* a plain greenish-brown hummer of Costa Rica and Ecuador, has an amazing sickle-shaped bill. Still another bizarre species is the Streamer-tailed Hummingbird, *Trochilus polytmus,* of Jamaica. Its body is green, the head black with long ear tufts, and it sports a long pair of magnificent tail plumes (up to seven inches long), set off by a scarlet black-tipped bill.

This gives you no more than a tantalizing glimpse of the beauty and variety of hummingbirds. But "pictures speak louder than words," and if you seek closer familiarity with these feathered gems, we refer you to the striking illustrated monographs by Gould and others, which you can find in the larger libraries.

Trogons—Beautiful, Delicate, and Shy

YOU ARE NOT likely to find many birds more attractive than the trogons with their glowing hues of carmine, orange, green, gold, and violet. The male is brilliantly attired and sometimes decorated with ornamental plumes, while the female is modestly dressed in browns and grays or only thinly washed with the brighter hues.

Unfortunately, trogons are not too robust. Their plumage is very soft, and the feathers drop easily. Their skin is remarkably delicate—so much so that ornithologists the world over are agreed that preparing a scientific specimen of a trogon calls for the most skillful kind of field taxidermy; one careless tug and the skin tears as readily as wet tissue paper. Trogons also have weak legs.

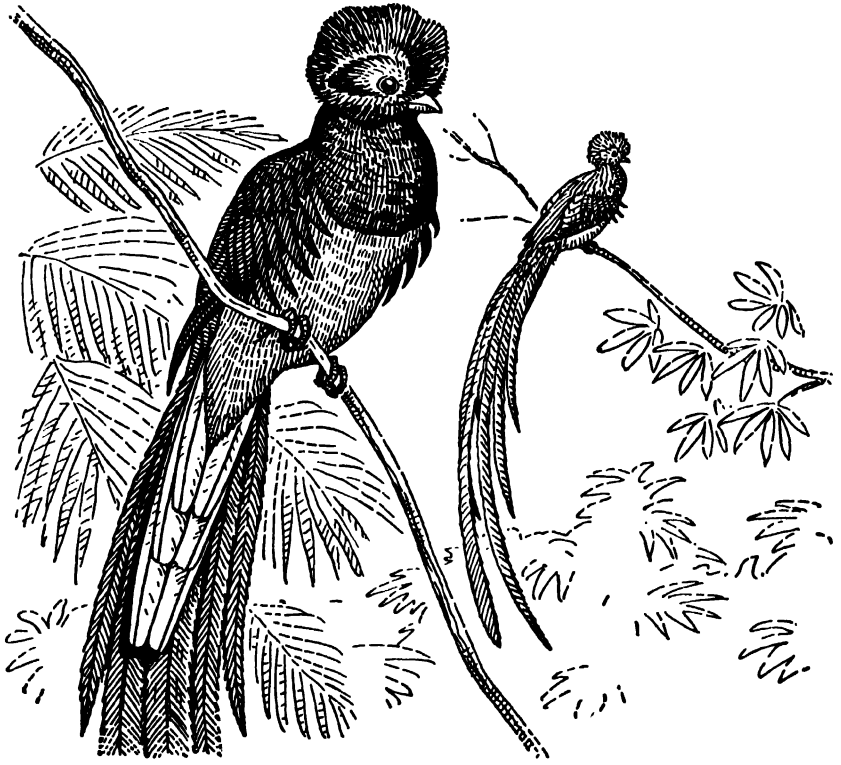
Trogons have no near relatives. An ancient tribe which epochs of geographical isolation have failed to alter appreciably, they now make their home in the tropics of Africa, Indo-Malaya, and America. There are some thirty-four known species, making up the order Trogoniformes. The discovery of a fossil trogon in France indicates that these birds formerly had a wider distribution than they have nowadays.

Trogons are rather silent birds of the deep forest or forest edge where they are usually found in pairs. They feed on insects caught on the wing, and supplement this fare with fruit. When they become vocal, they usually utter a series of gradually descending notes from high sentinel perches. They accompany these cries with jerky pulsations of the tail. Most species have a habit of sitting motionless for long periods, which makes it rather difficult to find them.

When we were in Panama we had the good fortune to observe the Massena Trogon, *Trogon massena,* in the Canal Zone. A female and her mate were building a nest by digging out a cavity in the side of a termite nest twenty feet up in a palm tree standing at the forest edge beside a lake. Woodpecker-like they clung to the nest and chopped

with their bills, frequently pausing to rub off the termite grubs which stuck to their heads and eyes. Many trogons nest in rotting trees, using holes which they dig themselves or take over. The female lays from two to four white, pale blue, or pale green eggs. The nestlings are naked when they emerge.

The Quetzal, *Pharomachrus mocinno,* the national bird of Guatemala, is considered by many the most beautiful bird in the world. Once the sacred bird of the Aztecs, the quetzal was associated with the worship of their benign god Quetzalcoatl, for whom they mistook Cortez when he came through the pass which bears his name, and descended like a scourge into the valley of Mexico.



THE QUETZAL—SACRED BIRD OF THE AZTECS

The green, scarlet, black and white quetzal is one of the outstandingly beautiful birds of the world. Its brilliant green train, two feet long, enhances its striking appearance.

Partly because of the quetzal's beauty, partly because of its sacred status, the Aztecs used its feathers for royal adornment.

You can distinguish the quetzal from all other trogons by the enormous length of the feathers above the tail which sometimes extend a good two feet—or even more—beyond the true tail. The quetzal has a large, rounded crest. Its upper parts are a rich, glittering green, as are the under parts from the head to the chest. The abdomen is scarlet, while the tail is black with broad white areas and the saber-like long feathers of the back are iridescent green. In parts of South America, natives call this bird the mountain hummingbird, but we may take it that the name is suggested by the brilliance of its plumage rather than by the method of flight. However, it is true that trogons frequently flutter as they feed on fruit.

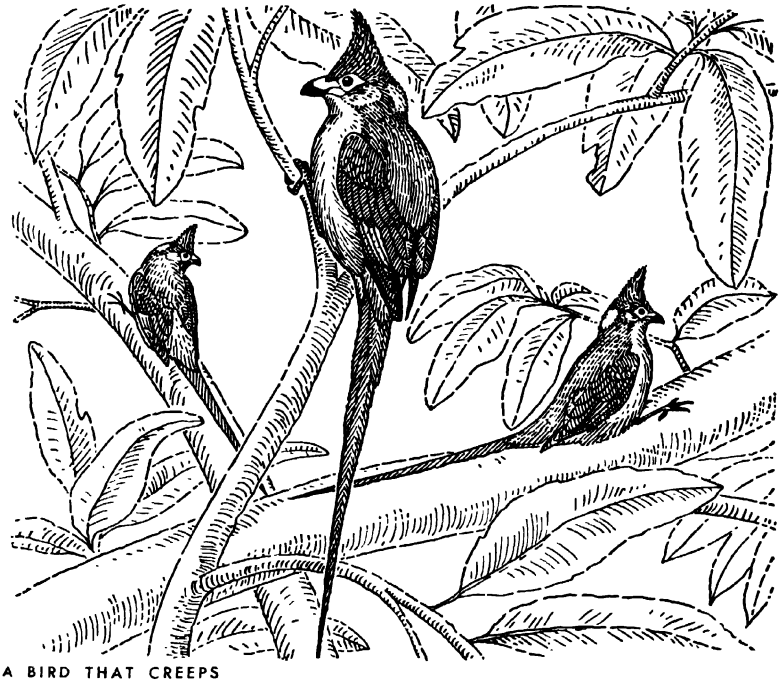
Striking as the quetzal's train is, there is at least one time when it is a definite nuisance. This is when the male aids his mate in incubating the eggs in a cramped hole in a tree. While sitting on the eggs, he bends the long feathers forward over his back and head.

In the mountains of southern Arizona we find a notable number of Mexican birds that reach only that area of the United States. Among them is the lovely Coppery-tailed Trogon, *Trogon ambiguus,* the northernmost member of the family in America.

Mousebirds or Colies—They Creep About

THE CURIOUS little mousebird of Africa was named for its habit of creeping about among the twigs of trees, where it feeds on fruit. Not much larger than a sparrow, the mousebird has a long pointed tail that brings its total length to about twelve inches. It is brown or tan in color, tinted with blue, and it sports a jaunty crest. (There are several species, making up the order Coliiformes.) Not

closely related to other birds, the mousebird does resemble the trogons in some ways. Its nest is a simple open cup, and the eggs are spotted.



A BIRD THAT CREEPS

The mousebird (or coly) of Africa got its name from its curious habit of creeping about in trees in quest of fruit and green shoots. When this interesting creature climbs, for sureness of footing it spreads out its toes in the shape of an X, and keeps the bottom of the foot close to the bark. The long tail is sometimes used as a prop.

Mousebirds live both in forests and more open country, and generally travel in flocks of from three to ten. When they roost, the members of the little band may hang by their feet and pack themselves together in a mass.

The mousebird, although it is famed as a creeper, is quite capable of flight. Indeed, it flies rapidly, but only for short distances.

Kingfishers, Hornbills, and Their Relatives

PERCHING QUIETLY on a limb above a pool—sometimes twenty feet above or even higher—the kingfisher awaits a favorable moment to dive like an arrow upon some unsuspecting minnow. Disappearing in a cloud of spray, the bird usually emerges in flight with the prey firmly held in its beak. After reaching a perch, the kingfisher quickly swallows the fish, head foremost. When it lacks the right kind of perch for watching, the kingfisher with its keen eyesight can discern schools of small fish as it flies above the water; a few minutes of hovering to pick its victim, and in it dives.

Aside from the kingfishers, this order (the Coraciiformes) includes the interestingly named todies, motmots, bee-eaters, rollers, hoopoes, and hornbills. They are tropical birds for the most part—only a few, such as the Belted Kingfisher of North America, reach northern latitudes. Bright colors are the rule for these birds. When it comes to size, there is an enormous range of difference, the todies being wren-sized while some hornbills are as large as an eagle. All these birds lay white eggs in a hole in the earth or in a tree or wall.

KINGFISHERS—BELLICOSE MONOPOLISTS

When you look at a kingfisher, you note that its head seems too large for its body. In combination with the businesslike bill (which is very large and pointed), the conspicuous crest, akin to an Indian headdress, reflects the pugnacious disposition of these birds. Kingfishers are very belligerent even toward others of their kind; a single pair will patrol a length of stream driving away all intruders. Their harsh rattling cry—it has been likened to a police whistle—is audible for

quite a distance, announcing to all kingfishers in the neighborhood that the territory is occupied. Occasionally destructive around fish hatcheries, the kingfisher lives mostly on useless or even harmful minnows.

While we find kingfishers in many parts of the world, the vast majority of the eighty-odd species—they make up the family Alcedinidae—are dwellers in the tropics. The familiar Belted Kingfisher, *Megaceryle alcyon,* of the United States, is typical of the tribe. A medium-sized, bluish-gray and white bird, it offers one of the few instances of the female being outfitted in brighter colors than her mate. The lady kingfisher has a chestnut band across the breast; the male lacks this band.

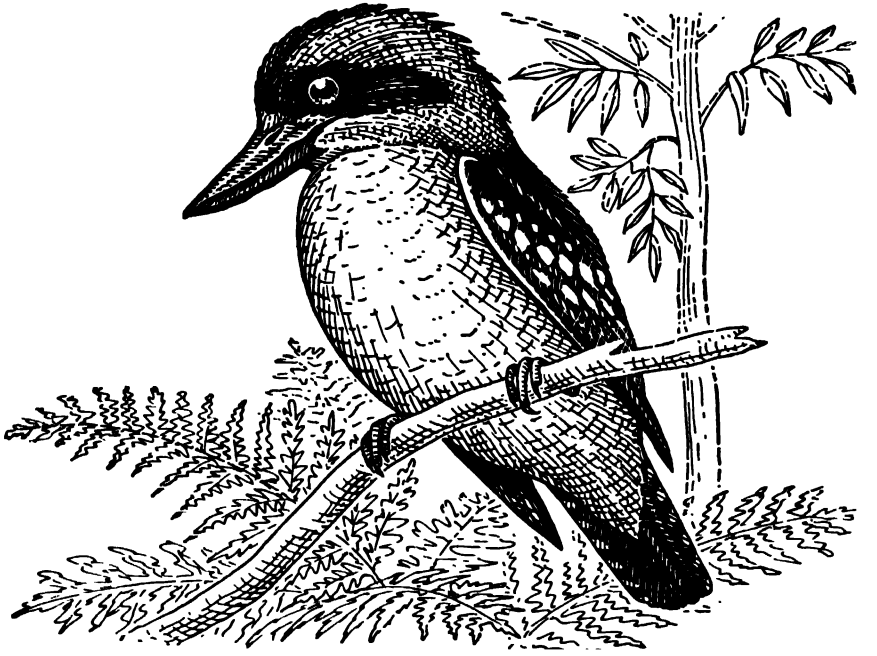
To the ancient Greeks the kingfisher was *alcyon* or *halcyon,* names that you may recognize in the phrase "halcyon days." This term harks back to an old legend that kingfishers build a floating nest on the ocean, and that the weather remains calm during the time that the eggs are being incubated. There is more charm than truth in this story, for actually kingfishers nest in hollow trees or in holes dug by the birds themselves in earthen banks. The nesting burrow of the belted kingfisher, dug in a steep bank and sometimes at a considerable distance from water, may be four feet or more in length.

The kingfisher builds no nest. It lays as many as eight white eggs in a rounded cavity at the end of the burrow. The bones and scales of fish are cast up by these birds in the form of pellets. What with all the fish the parents consume or feed to the babies, the nest chamber gets to be a very "fishy" place indeed.

OLD WORLD KINGFISHERS—INCLUDING A LAUGHING JACKASS

The Australian Laughing Jackass or Kookaburra, *Dacelo novaeguineae,* is the most unusual of the kingfishers, and the largest. This bird's cry is a discordant, abrupt laugh, said to be even more startling than the hyena's. As a rule the kookaburra does not catch fish, feeding instead on crabs, large insects, mice, rats, and reptiles. During the nesting season of small birds, the kookaburra often robs their nests. Not all the kingfishers of the Old World are "fishers" in the literal sense of the word; in fact, many of them have feeding habits similar to the kookaburra's.

The laughing jackass is rather pleasantly patterned in brown over most of its body. Some of its cousins in the Oriental region go in for more brilliant colors—maroon and metallic blues. The long-tailed Paradise Kingfishers, *Tanysiptera,* are perhaps the most beautiful of the family. It is a pity that since they inhabit the thinly settled coasts of New Guinea and nearby islands, few of us can ever have an opportunity to appreciate their beauty.



THE LAUGHING JACKASS OF AUSTRALIA

The laughing jackass, also known as the kookaburra, is a member of the kingfisher family. This bird has a strange laughlike cry that is more startling than mirthful. It feeds on such creatures as crabs, rats, mice, and reptiles.

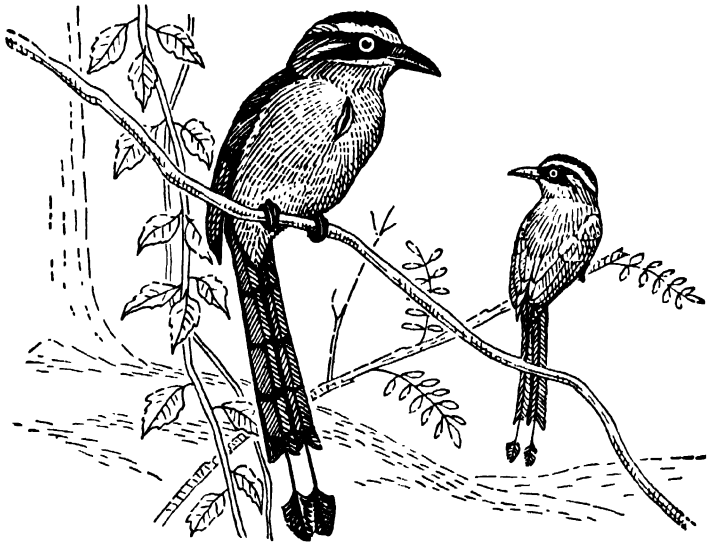
TODIES—BIRDS OF THE WEST INDIES

We find these curious little birds only in the West Indies, where each of the larger islands has its own distinct species. No larger than a wren, the birds, all members of the family Todidae, have a bright green back and scarlet throat. They have a habit of sitting quietly on a twig in the shade and making occasional sallies after flying in-

sects, which they seize in their broad, flat bills. Like the motmots, to whom they are most nearly related, they dig holes in the earth where they lay their clutch of white eggs.

MOTMOTS—THEY TRIM THEIR TAILS

Handsome, graceful, medium-sized birds, the motmots of tropical America have a peculiar racket-tipped tail. Male and female are dressed alike, and immature birds resemble the grownups—with the difference that adults may have incomplete rackets on the tail. We are told that motmots clip the tail shafts with their bills, thus form-



THE MOTMOT TRIMS ITS TAIL

An attractive bird, the motmot is famous for its supposed habit of trimming off its tail feathers with its bill until the tail takes on a racket shape. It twitches its tail from side to side in a curious manner—perhaps the racket-tips serve as a signal.

ing their racket shape. However, the feathers in the "notch" areas are weaker, and perhaps shear off through the normal action of preening. Whatever the answer may be, we know that the plumes are removed slowly, sometimes along one side of the feather at a time, sometimes on both sides, until nothing but the nude shaft remains to link the "flag" to the remainder of the tail.

We do not know how this habit of trimming the tail originated,

nor do we know what possible useful purpose it may serve. The tail jerks nervously whenever the motmot sounds its notes (for which it is named), and it is twitched occasionally as the bird perches quietly in the lower portions of the gloomy tropical jungle. It may be that such actions serve as a bond between a pair of motmots.

There are eight species of motmots, all members of the family Momotidae and all related to the todies of the West Indies, and probably to the bee-eaters of the Old World. They are equipped with a black bill that has notched or saw-toothed edges. The largest of the clan, the Common Motmot, *Momotus momota,* of South America and Mexico, is fourteen inches long. It has yellowish-olive plumage with a spot of black on the chest, a black face, and a cobalt-blue crown and tail flags. The smallest and most primitive of these birds, the starling-sized Tody Motmot, *Hylomanes momotula,* of southern Mexico and Central America, is dull green and brown with a cinnamon head and neck, and bright-green eye stripes. This bird does not trim its tail in the manner we have described.

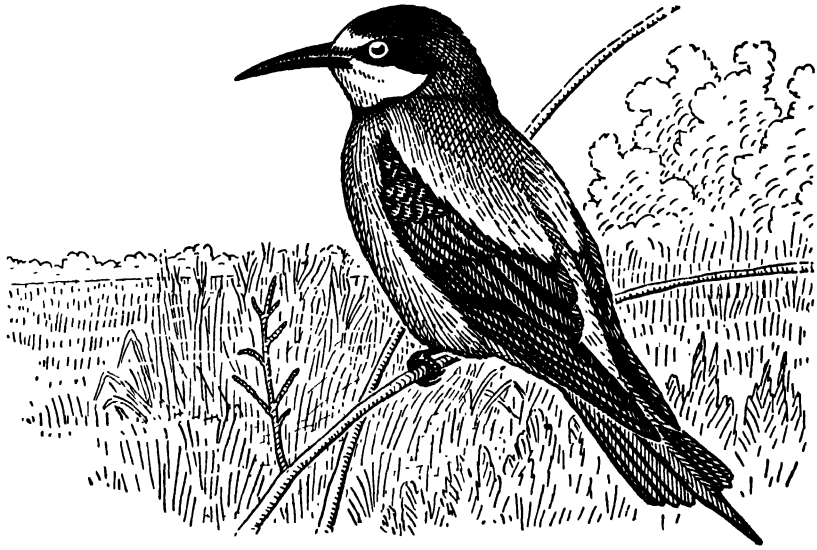
Motmots perch at moderate heights above the ground, often near water. They are usually thinly distributed, and we have learned to expect no more than a pair, or a solitary individual, for every mile or so of jungle trail. Motmots capture insects in flight, darting out from low perches like flycatchers. However, they are less likely to be attached to any single perch than many flycatching birds are. The motmot's nest may be an abandoned woodpecker hole or a tunnel which the birds dig near the water. The female lays three or four glossy white eggs, which are incubated by both parents.

BEE-EATERS—HANDSOME BIRDS

Bee-eaters spend much of their time swooping gracefully through the air in search of bees and other insects. They are sociable birds, uttering mellow notes while on the wing to aid the members of a flock in keeping together. When ready to nest, the colony selects a bank and each pair digs a nesting burrow.

The Common Bee-eater, *Merops apiaster,* is one of the twenty-four species of bee-eaters. (They make up the family Meropidae.) Like their cousins the rollers, these birds are natives of the warmer parts of the Old World. The common bee-eater may nest as far north as

Denmark, but its true home extends from the south of Spain and France through the Mediterranean area to Persia and beyond. It is highly migratory, wintering in South Africa.



A BIRD THAT FEEDS ON BEES

The bee-eater is an exceptionally good-looking bird and a graceful flier. It feeds not only on bees, but on other insects as well. Though the bee-eater may nest as far north as Denmark, it prefers the warmer regions.

This bee-eater is a marvel of softly blended pastel shades. Its upper parts are largely chestnut brown becoming reddish yellow on the rump. The wing and tail quills are bluish green, the former tipped with black. A band of deep blue-black extends around the throat. With its long, pointed wings and greatly elongated central tail feathers, the bird is able to float through the air with all the ease of a swallow. Some of the African bee-eaters are even more attractive, and few birds can match them in beauty.

ROLLERS—ANOTHER GROUP OF GRACEFUL BIRDS

At times, particularly when they are courting, these birds roll and tumble through the air—hence the name "roller." They are colorful birds. The tint of the head, neck, and breast in many rollers is that

peculiar greenish blue that artists term "verditer." The back is a warm chestnut-brown changing to purple on the lower back.

This small Old World family of sixteen species (the Coraciidae) is related to the kingfishers and motmots. We find these birds mainly in the tropics, but the Common Roller, *Coracias garrulus,* nests as far north as Denmark. Rollers lay their white eggs in the cavity of a tree.

The Oriental Roller or Dollarbird, *Eurystomus orientalis,* gets its curious common name from a light-bluish area in its wings the size of a silver dollar. We find this bird all the way from southern Siberia to Australia. The Siberian birds migrate south into the Philippines and East Indies; those of Australia migrate north into New Guinea and nearby islands. A dark blue creature with a red bill, the dollarbird chooses a conspicuous perch on a dead limb while on the lookout for flying insects, and swoops after any it may spy. Many American soldiers stationed in the South Pacific during the war became familiar with this colorful bird.

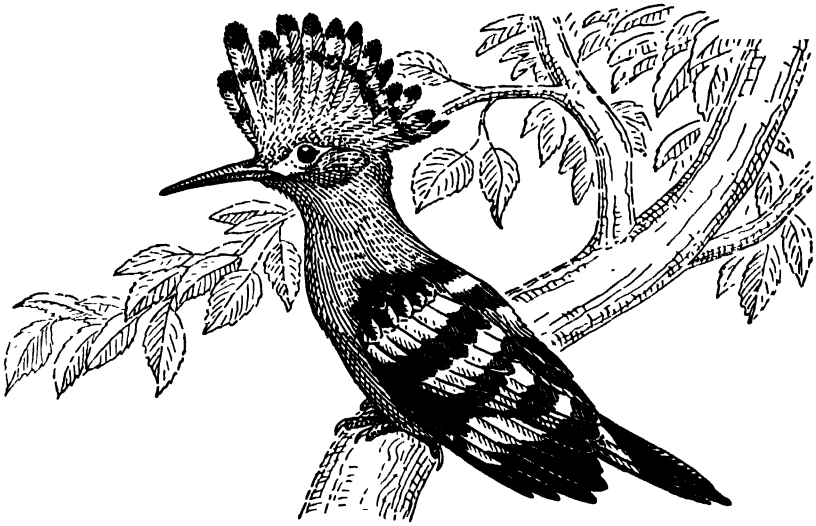
Several of the African rollers have a long pointed tail, and are even more graceful in appearance than their Asiatic cousins. The curious Ground-rollers of Madagascar have longer legs and shorter wings than the other members of the family. As you might therefore expect, they spend much time on the ground or in low bushes.

HOOPOES—NAMED FOR THEIR MELLOW CALL

The Hoopoe, *Upupa epops,* named after its mellow call, "hoo-poo," makes its home in many parts of the Old World north to France. The long crest that runs the length of its crown, makes it a conspicuous bird as it stalks along the ground nodding its head and expanding and contracting the crest. About a foot in length, the hoopoe has a variegated pattern of white, buff, and black. Its oil glands have a disagreeable odor.

The hoopoe's food is largely insects—particularly ants, which it digs from the ground with its long, curved beak. The nest is placed in a hollow tree, and once the female begins incubating she is fed by her mate and hardly ever leaves the nest. In this respect the hoopoes are like the hornbills. Hoopoes compose the family Upupidae.

In Africa we find two or three birds related to the hoopoe but more at home in trees. They are called tree-hoopoes, and sometimes placed in a separate family.



HOOPOE—A BIRD WITH INDIAN HEADDRESS

An Old World bird, the hoopoe has been named for its call. The hoopoe's favorite food is ants—its long, curved beak is ideally shaped for prying them out of the ground. Its conspicuous crest gives it a very amusing appearance.

HORNBILLS AND THEIR REMARKABLE NESTING HABITS

Hornbills are medium-sized or large birds that dwell in Asia and Africa, usually in the jungles. Their most prominent feature, as you can gather from their name, is the very large bill, which bears a sizable, brightly colored, horny growth—the casque. Though the bird has the appearance of being out of balance, the casque is generally very light, being made up largely of thin-walled hollow cells.

The hornbill is famous, and deservedly so, for its unique nesting habits. Once courtship and mating are over, the female retires to a hollow tree and seals herself into the chamber with an adobe-like substance made up of dung and pellets of mud. These materials the male gathers on the forest floor and swallows. Later he expels them in the form of small saliva-permeated pellets which he "hands" to the female who remains inside the nest. She promptly plasters them on

the sides of the entrance. At last only a slitlike window remains which is just big enough to receive part of the bill. For the next six or eight weeks the attentive and anxious male feeds the female through this opening. The imprisoned female lays a few white eggs. While incubating, she begins a complete molt and for a time is flightless, having lost all her wing and tail feathers.

Among many hornbills the female breaks her way out of the nest a week or more before the young are ready to leave the shelter. Dressed in a fresh cloak of feathers, she helps her mate feed the young. With an amazing display of instinct, the babies immediately rebuild the entrance barrier. At this stage they are comical little fellows that sit like tiny little penguins with the long tail clamped tightly to their backs. They assume this posture even when removed from the nest.

Most hornbills are black and white, sometimes varied with chestnut or gray. Their legs and feet are short and rather weak, except in the curious African Ground Hornbills, *Bucorvus,* which catch many insects and even mice—whereas the more typical hornbills are fruit-eaters. The two species of ground hornbills also differ from all the others in not plastering shut the entrance to the nest. Some forty-six species make up the family.

In their native habitat, hornbills are active birds of the forest canopy. Leaping from bough to bough and thrashing lightly about on the tips of the tallest fruiting trees, they usually appear not in the least encumbered by the ungainly bill. Their flight is heavy and sluggish. In the morning and evening the hornbill is likely to descend to the ground to feed, bathe, and collect damp earth. At such times, instead of walking soberly along as might be expected of such a large bird, it hops about ludicrously.

Among the members of this family (the Bucerotidae) we find several that are especially amusing in behavior or appearance. One of these is the Rufous Hornbill or Calao, *Buceros hydrocorax,* of the Philippines. Without a doubt this bird is the most obstreperous denizen of the forest, because of its powerful, oft-repeated cry and its unbelievably noisy flight—a sound which has the hissing quality of a low glider or defective bomb. A former infantryman we know insists that he was once in an open column of men moving along a forest road on Bataan when the point man, hearing the wind whistling through the wings of a low-flying hornbill, hit the dirt instinctively.

Among the largest members of the family is the Rhinoceros Hornbill, *Buceros rhinoceros,* named for the shape of its casque. The Helmeted Hornbill, *Rhinoplax vigil,* of the East Indies, has central tail feathers some three or four feet long. Its total length is as much as



THE RHINOCEROS HORNBILL—JUNGLE GIANT

All hornbills have a very prominent bill—the striking shape of the one belonging to the rhinoceros hornbill is responsible for its name. The members of the hornbill clan are noted for their unique nesting habits—the female seals herself in the nest with mud!

six feet. Unlike the tail feathers of other birds, the two central tail feathers do not drop out and molt together. Instead, they are replaced alternately, so that at least one of these long tail feathers is always present to act as a rudder.

Woodpeckers, Toucans, Honey Guides, and Their Relatives

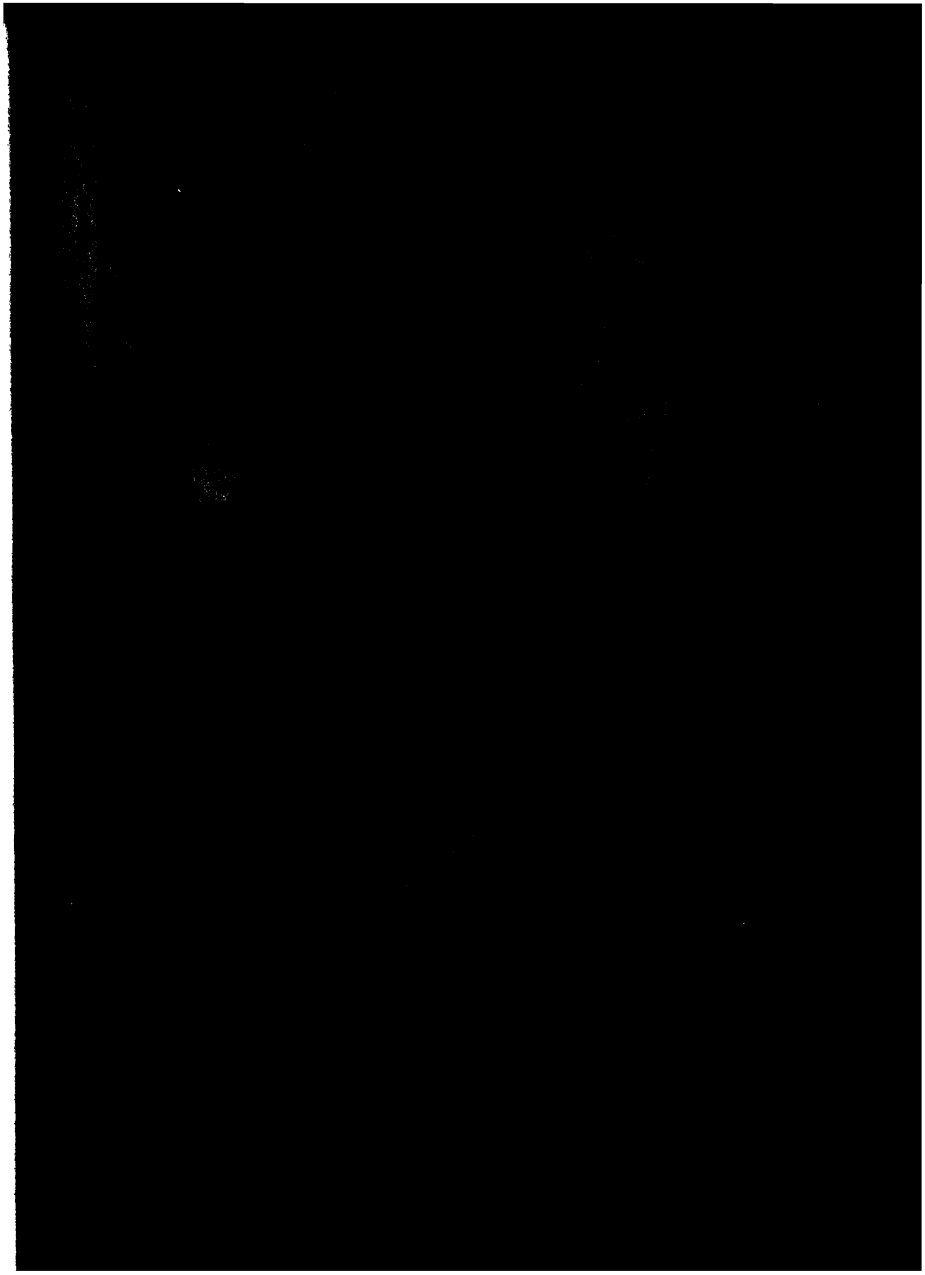
THESE BIRDS are climbers and diggers. They all have a "yoke-toed" foot with two toes directed backward and two forward. This arrangement is obviously useful to woodpeckers in climbing on tree trunks; the other birds of this order often have somewhat similar habits, though they are less specialized for climbing and for digging in wood. Woodpeckers, the best-known family, are found in most parts of the world except Australia and New Guinea. The jacamars, puffbirds, and toucans make their home in the American tropics. As for the honey guides and barbets, they also live in the tropics—the former in Africa and Asia, the latter in both the Old World and the New.

The birds belonging to this group (the order Piciformes) lay white eggs in a hole in a tree or occasionally in the earth. As a rule they dig this nesting chamber themselves. The honey guides have parasitic habits, laying their eggs in the nests of other birds—particularly their cousins, the barbets. Toucans and barbets are generally brightly colored, woodpeckers and jacamars somewhat less so, while the puffbirds and honey guides are often plain brown or gray, sometimes with a patch of yellow on the back.

JACAMARS—QUIET BIRDS OF THE FOREST

Jacamars haunt the outer edge of high tropical forest, overlooking grassy fields and meandering streams. They sally out after flying insects from favorite perches, but when they are not actively feeding they often sit quietly and inconspicuously for long periods.

Ranging from southern Mexico to southern Brazil, the fifteen spe-



me by Cleveland Grant

American Museum of Natural History

A MALE BLUEBIRD RESTS IN FRONT OF HIS NEST OPENING
The bluebird, wrote John Burroughs, has the sky on its back and the rich earth on its breast. The mellow warble of the first bluebird, as it returns early in the spring, is always welcomed by country folk. Often this bird remains to nest in a cavity in an apple tree or in a mailbox.

ties of jacamars—they comprise the family Galbulidae—are starling-sized, with a long, slender tail and a long, almost straight bill. They are usually glossy and bronzy green above, dull cinnamon or blackish brown below, and often the throat is white. Male and female are colored alike. Their nest is a narrow burrow drilled deep into a shallow bank; sometimes a tree cavity is used. The female lays three glossy white eggs, and the young are born blind and naked. But both parents help feed the young, and if the female meets with an accident her mate will take complete care of the chicks.

Perhaps the most beautiful of the jacamars is the Great Jacamar, *Jacamerops aurea,* of central and northern South America. About twelve inches long, it has glistening, bronzy-green upper parts, a slightly curved bill, a glossy green chin, a white throat, and cinnamon-colored under parts. The Paradise Jacamar, *Urogalba dea,* has a broad white throat. It is a slender bird ten inches long with a dark brownish head and generally blackish plumage with deep green and blue reflections. The Bronzy-breasted Jacamar, *Galbula leucogaster,* is eight inches long with a bronze-green body, white throat, and bluish head.

PUFFBIRDS—BLASÉ AND ALOOF

Fearless though rather inactive birds of the forest, puffbirds have the same blasé aloofness as jacamars, often completely ignoring man or appearing half asleep. The way puffbirds expand the fluffy plumage of the crown and neck gives us the origin of their name. They are related to the jacamars, but instead of the glossy sheen of those birds they have plain black, brown, or blue plumage. There are thirty species of puffbirds. They make up the family Bucconidae, and they all live in tropical America, from southern Mexico to Argentina. Most of them dwell on the forest edge or on savannas containing trees and bushes, usually near water; a few live in the middle and lower tiers of deep forest.

Of these forest dwellers, the Lance-billed Puffbird, *Micromonacha lanceolata,* of northern South America, is the smallest—only five inches in length. With its coffee-brown upper parts, white under parts with blackish spots and streaks, it has the appearance of a miniature wood thrush. The Black-collared Puffbird, *Bucco capensis,* is peculiar-looking because of its huge head. A starling-sized bird, it

is chestnut above, strongly marked with black wavy lines. A distinctive black band encircles the body in the region of the chest and shoulders. This bird and the Swallow-wing, *Chelidoptera tenebrosa,* are perhaps the most familiar puffbirds of the open forest edge where they hunt insects like flycatchers.

Very quiet, if not mute, most puffbirds frequently sit motionless for long periods. But the nunbirds, which are members of this family, often emit whistling notes when traveling in flocks in the company of ant wrens, ant shrikes, and woodhewers in deep forest. The White-bearded Nunbird, *Monasa morphoeus,* of South America, is typical of this group. It is a blackish-gray, thrush-sized bird with a scarlet bill encircled by white feathers. Bonaparte's Puffbird, *Notharchus hyperrhynchus,* is one of the largest of the family. Ranging from southern Mexico to South America, it is a kingfisher-like bird with a heavy black bill, black body; the forehead, throat, collar, and under tail coverts are all white.

All puffbirds nest in holes either in trees or in earthen banks. Their eggs are glossy white.

BARBETS—PRACTICALLY INVISIBLE IN THE TREETOPS

As an aid in the process of funneling insects into its mouth, the barbet has a frame of hairlike feathers on its somewhat oversized bill. It was this characteristic that suggested the word *barbu* ("bearded") to the French ornithologist Brisson, leading to the coining of the name "barbet." Like the bill, this bird's head is also somewhat large for its small or moderately sized but stocky body.

The seventy-odd species of barbets (family Capitonidae) all have short legs and are equipped with paired toes directed forward and backwards as in their near relatives, the toucans and woodpeckers. But—notably unlike the woodpeckers—the barbets are weak climbers; they prefer to hop and walk about on their thin limbs rather than ascend vertical surfaces. They are partial to dwelling in treetops, where, despite their brilliant coloring, they are invisible in silhouette.

The green and yellow Crimson-breasted Barbet of the Philippines, *Megalaima haemacephala,* is rarely seen because it is perfectly quiet while feeding and moves about with great deliberation. In the village of Lamao on southern Bataan, flocks of these barbets came regularly

to a tall fruiting tree to feed, although local boys peppered them daily with slingshots, killing quite a few. During a brief stroll we noticed one of these barbets as it clung to the side of a stub and hammered noisily with its bill at what was evidently to be a nesting burrow. All barbets dig their nesting chambers in this way—but only in rotten wood, for their bill is by no means so efficient a chisel as a woodpecker's. Some of the African barbets are sociable, several pairs nesting in the same dead tree.

Nearly all barbets have patches of bright plumage. For example, the sparrow-sized Yellow-breasted Tinkerbird, *Pogoniulus erythonotus*, of Central Africa, has a brilliant crimson rump. The starling-sized Blue-throated Barbet, *Megalaima asiatica*, of Indo-Malaya, is purplish blue on the face, neck, and upper chest, with bright patches of scarlet on the crown and chest. The Many-colored Barbet, *Capito versicolor,* of South America, is an aptly named, sparrow-sized, greenish bird. It has golden yellow on the cheeks and chest, a broad, incomplete, lavender collar, and vivid patches of scarlet on the head, throat, and lower chest. Thus you see that the bright colors of barbets are often gaudy and clashing.

WOODPECKERS—CLIMBERS, BORERS, DRUMMERS

Woodpeckers are such familiar birds that it is easy for us to take them for granted, forgetting about the many ways that nature has equipped them for their lifework—constantly digging in wood to find grubs, or to make holes in which to sleep and nest. In almost all of the 225 or so known kinds of woodpeckers, we find a bill that is strong and chisel-shaped. They have powerful neck muscles to give the bill extra driving strength, and the bony structure of the head is modified to resist the constant hammering to which it is subjected. The woodpecker has a long tongue which it can thrust out for a remarkable distance. Little barbs on the tip help pull grubs from their burrows. Incidentally, what makes it possible for the woodpecker to protrude its tongue so far is an arrangement much like the hummingbird's—the hyoid (tongue) bones are extremely long and curve around beneath and in back of the skull; then they run forward on top of the skull beneath the skin until they reach the forehead.

But this by no means concludes the list of the woodpecker's special equipment. Its feet are powerful, its claws strong and sharply

hooked; two toes point forward, two sideways and backward. The tail feathers are stiff and pointed—excellent for a prop when the bird is clinging to a tree trunk. If you have ever watched a woodpecker at work, you have noticed that it climbs trees by a series of short hops, and not by a continuous alternate movement of the legs.

Almost all woodpeckers nest in holes in trees. As a rule they construct their own housing; a few, the flicker, for example, sometimes use a birdhouse or a ready-made cavity. The eggs are a glossy, pure white—four to eight in a clutch. When hatched, the young are naked and homely. As they grow older they become very noisy when hungry, and they utter loud, hissing or rasping cries. Among several members of the woodpecker tribe (it is known as the family Picidae) the proverbial solicitude of the mother is at a low ebb; the male is more active than his mate when it comes to feeding the young, and sometimes the mother loses all interest in her offspring long before they leave the nest.

The little Downy Woodpecker, *Dendrocopos pubescens,* is the best known of all the American species. It is slightly larger than a sparrow, and you can distinguish it by the sharply barred black and white pattern of its plumage. Like many other woodpeckers, the male has a bright crimson spot on the back of his head.

Woodpeckers often attract our attention by a loud tapping as they dig in soft wood. So ingrained is this habit that the woodpecker's usual "song" is really a drumming produced by tapping on a resonant dead limb. The bird performs so rapidly that your eye cannot follow the movements of its head, nor can your ear separate the rolling notes. The downy woodpecker also utters a whinny-like series of high-pitched notes and a sharp "peent" of alarm.

The Hairy Woodpecker, *Dendrocopos villosus,* looks very much like the "downy" except that it is larger, about the size of a starling. Unlike its smaller cousin, which is partial to orchards or shade trees, the hairy woodpecker favors rather extensive woodlands.

The Flicker, *Colaptes auratus,* spends a great deal of time feeding on the ground, often hopping about like a robin. It is very fond of ants, and consumes a good many other insect pests. At times it feeds on tree trunks or branches like other woodpeckers, and the nest chamber it digs in soft wood has the general shape of a gourd or summer squash.

The flicker has a variety of loud notes—one of them sounds like "flick-er," and there we have the origin of its common name. Its scientific name *auratus* ("golden") is derived from the gold color of the under surface of the wings. Found throughout North America, it is a large and conspicuous woodpecker. Its basic color is brown, and it is barred above and spotted below with black, with a prominent white patch on the lower back. The male has black, mustache-like marks on the side of the head, and a red nape. These marks vary somewhat in different parts of the continent.

FLYCATCHING WOODPECKERS

Though most woodpeckers live upon insects of one sort or another, they also take fruits and nuts. The California Woodpecker or Acorn Woodpecker, *Melanerpes formicivorus,* drills long rows of shallow holes in a tree trunk. In each hole it sticks an acorn, which it may eat later when food is scarce.

Another method of feeding hardly to be expected of woodpeckers is capturing flying insects in midair. The beautiful Redheaded Woodpecker, *Melanerpes erythrocephalus* ("red head"), frequently sallies out from a telephone pole or other exposed perch after large flying insects. This good-looking woodpecker has a black and white body which effectively sets off its crimson head. Common in the Midwest, it is found only locally in the eastern part of the United States.

The large and handsomely colored Lewis Woodpecker, *Asyndesmus lewis,* named after one of the famous leaders of the Lewis and Clark Expedition, dwells in the Great Basin region of the United States. This bird, which captures insects every bit as gracefully as a flycatcher, is a rich, glossy black above, and gray, tinged with salmon red, below. On a recent trip to Sonora, Mexico, we were told by the local boys that the *carpintiero negro,* as they call this bird, lived in the vicinity in winter. Soon we saw several Lewis woodpeckers hawking for insects from the top of a large dead tree.

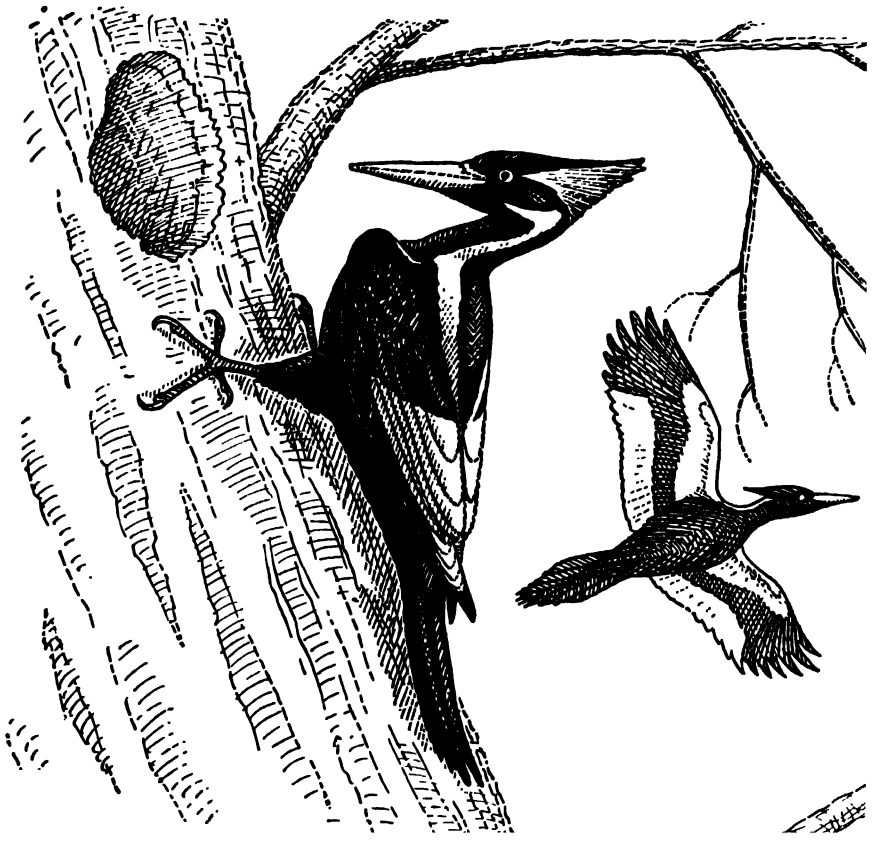
SAPSUCKERS

The Sapsuckers, *Spyrapicus,* have literally tapped another source of food. In springtime they dig long rows of holes in the bark of trees and later return to drink the sap oozing from these wounds. In this way they often do considerable damage to fruit trees.

In the San Francisco Mountains of Arizona we once traced a noisy clattering echoing through the forest; we were amused to find a sapsucker using a tin sign as a sounding board for its drumming.

PILEATED AND IVORY-BILLED WOODPECKERS

The largest woodpecker of general occurrence in North America is the Pileated Woodpecker or Logcock, *Dryocopus pileatus* (from *pileum*, a crest). An imposing bird with flaming red crest and contrasting black and white plumage, it is only slightly smaller than a crow



A WOODPECKER THREATENED WITH EXTINCTION

The magnificent ivory-billed woodpecker, once common in the southern United States, is almost extinct. Woodpeckers are wonderfully adapted for pecking and drumming on wood —they have a chisel-shaped bill, a modified bony structure of the head to resist hammering, and powerful feet to get a strong grip on tree trunks.

It possesses great strength and digs large furrows and holes in trees to get at its favorite food, carpenter ants. These ants attack the heart wood of trees, entering from the base; so, to reach them the logcock must often drill through two or three inches of hard wood. Like most other woodpeckers, this species does not migrate. During the winter it digs a sleeping chamber for itself in a large tree.

The magnificent Ivory-billed Woodpecker, *Campephilus principalis*, was formerly found throughout the southern United States, but it is almost extinct. Similar to the pileated woodpecker in appearance, it was larger and had a huge ivory-white bill. It was at home in primeval forests, and the widespread lumbering operations of recent years doomed it. Related ivory-bills live in Cuba and Mexico, but their numbers are greatly reduced.

OTHER WOODPECKERS

The Wryneck, *Jynx torquilla,* is an Old World bird named for its habit of twisting its neck while peering about for food. It is a peculiar and primitive woodpecker—its tail feathers are not modified for clinging to tree trunks. Like the American flicker, but to a greater extent, it feeds on the ground upon ants or other insects.

The Piculets (diminutive of *Picus,* a woodpecker) are tiny birds, much smaller than a house sparrow. We find them in the tropics of both hemispheres. Like the wrynecks, they have unmodified tails. However, instead of feeding on the ground, they climb around on branches in search of insects, more or less in the manner of nuthatches.

TOUCANS AND THEIR HUGE BILLS

The toucan's bill is so large that when you see it you wonder how the bird can maintain its balance. The fact is that this inflated bill, though strong, is very light. While the toucan has no trouble standing, it might well have some when it comes to bedding down. However, the bird solves this problem ingeniously by packing itself up in a systematic manner. First the head is turned backward and laid sidewise on the top of the back. Then the fanlike tail is spread out and folded over the gaudy bill and back!

Some naturalists have suggested that the toucan uses this long bill

to reach otherwise inaccessible fruits or berries. But this theory seems far fetched and does not explain the brilliant color pattern of the toucan bill, which varies from species to species and very likely is of value in courtship or pairing.

The thirty-seven species of these huge-billed birds (the family Ramphastidae) live in tropical forests ranging from Mexico to Argentina. We find most of them near sea level, with a small number reaching high elevations in the Andes. Though the toucans' closest kinship is with the barbets and woodpeckers, the large bill reminds us of the hornbills of Asia and Africa. Indeed, we find many similarities in habit between toucans and hornbills. Both feed on fruit and seeds and relish young birds, eggs, and insects. Both nest in cavities high in forest trees. In flight, both are sluggish though not ungraceful, thrashing the air noisily with their pinions, with the hornbill much the louder. Another point of resemblance is that both birds are noisy screamers.

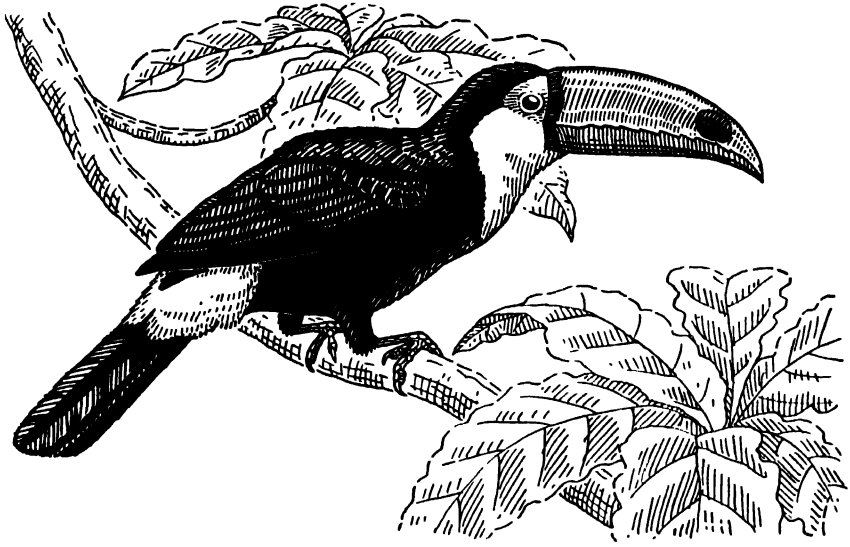
Toucans, some of whom cry "tucano"—hence the name—often gather in flocks on high branches of the forest. There they seem to be arguing violently, lifting their bills together, chattering hoarsely, their bugling synchronized with rapid upward swings of the massive bill Because of this trait they are called "preacher birds" in some localities.

The largest of the toucans, the Toco, *Ramphastos toco,* is crow-sized. It is black, with the rump, throat, and sides of face and neck white, the under tail coverts scarlet, the eye-ring blue, and the bill orange banded with black. Related toucans have yellow or orange on the throat or rump. The Gray-breasted Toucan, *Andigena hypoglaucus,* another large bird, dwells in the northern Andes from Colombia to Peru. Deep brownish green above, it has a black crown, yellow rump, and reddish-tipped tail. The under parts are pale bluish gray The least noticeable and little known members of the family, the Tucanets, *Aulacorhynchus,* are greenish birds with a much smaller bill. They live in mountain rain forests—sometimes at altitudes of eight thousand feet. We have found them dwelling in the crowns of great mist-cloaked trees.

The most unbelievable member of the toucan tribe is the Curl-crested Aracari, *Beauharnaisius,* of Peru and Brazil. This bird has a head covering of curled and rumpled cellophane-like crown feathers. Otherwise it is modestly dressed in dark green with red on the back,

rump, and flanks. Another interesting toucan is the Collared Aracari, *Pteroglossus torquatus,* of Mexico and northern South America. A medium-sized bird with a scarlet rump, reddish collar, and a red and yellow breast, it has bill markings that resemble huge saw teeth.

We are told that toucans are easily tamed and make amusing pets.



THE TOCO—BIGGEST OF THE TOUCANS

The toucan's brightly colored bill is so large that the bird has to make elaborate sleeping arrangements First it turns its head backward and lays it sidewise on the top of its back. Then it spreads out its tail like a fan, folding it over the bill and back. Now the toucan is ready for sleep! Toucans are noisy—they are sometimes called "preacher birds."

HONEY GUIDES—THEY HAVE A PASSION FOR HONEYCOMB

The scientific name of the Common Honey Guide, *Indicator indicator*, tells you that this bird points out something. The story behind that name is one of the most fascinating you may encounter among any birds. What this honey guide does is to indicate or point out the nests of wild bees to man. This it does by constantly chattering until it draws the traveler's attention, and then flying ahead until it reveals the hive! The African natives who profit by this behavior then usually break open the bees' nest and take the honey. However, they leave some of the comb for the bird, which consumes it avidly.

From what we know of birds' intelligence—or rather lack of it—we cannot believe that the honey guide reasons out this method of securing food. Rather we must suppose that over a long period of time an instinctive type of behavior has developed, with some four-footed honey-eater, perhaps the honey badger, and not man, serving as the original partner. We also have reports that the honey guide sometimes leads men to the neighborhood of leopards or venomous serpents, but these tales do not seem to have any basis in fact. Although most, if not all, honey guides are partial to honeycomb, only one or two species have evolved this "guiding" behavior.

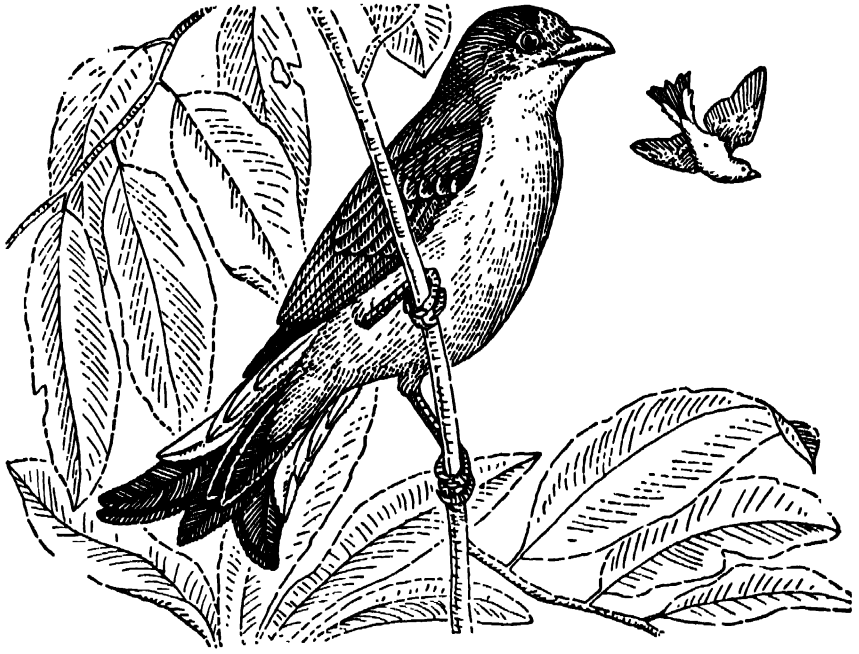
Another remarkable trait of honey guides is that they are all parasitic in their nesting habits. They usually impose their eggs on hole-nesting birds, especially the related barbets. The young honey guide is then hatched and reared by the foster parent. At the time of hatching the little honey guide has a wicked-looking hook at the end of its bill. Perhaps it uses this hook to kill the young barbets or other baby birds in whose home it finds itself. After the honey guide is a few days old this hook disappears.

This family (the Indicatoridae) contains only eleven species, all somberly colored birds of little or no economic importance. Two species dwell in Asia, the rest in Africa.

The African Lyre-tailed Honey Guide, *Melichneutes,* though found over most of the African forests, is still very rare in museum collections. The central tail feathers of this bird are somewhat lengthened and lyrate (shaped like a lyre), while the outer ones are short and stiff. Dr. James P. Chapin, one of the few naturalists who have seen and collected the lyre-tailed honey guide, believes that these specialized tail feathers are the source of a mysterious, intermittent, nasal or whining sound often heard high above the forest. The bird swoops through the air and its tail feathers vibrate, producing the sound. Even the keen-eyed natives are uncertain as to the origin of this sound, although some of them admit it is produced by a bird. The small size and dull coloring of this honey guide make it difficult to trace the noise to its source. It is hard to see any small moving object through the high canopy of jungle trees against the brilliant sky.

The Himalayan Honey Guide, *Indicator xanthonotus,* is likewise something of a bird of mystery, as it had not been seen in over fifty years up to recent times. But a few years ago Dr. Walter Koelz ob-

served considerable numbers of them visiting wild bees' nests along rocky ridges in Nepal. Another naturalist—this time in Burma—saw one of these honey guides catching insects like a flycatcher. The Himalayan honey guide's tail feathers are somewhat stiffened and short-



IT "PLAYS ITS LYRE" ABOVE THE JUNGLE

The lyre-tailed honey guide is the most mysterious member of the fascinating honey-guide group. As it zooms high above the jungle, the air rushes through its stiff, lyre-shaped tail feathers, producing a whining noise. Perhaps this sound guides some forest animal to hidden honey, just the way the noise made by some other honey guides serves to reveal such a cache to man.

ened—an indication to us that it is in the early stage of the specialization we find in the African lyre-tail. The Himalayan bird has a bright yellow patch of feathers on the lower back; the other Asiatic honey guide, found in the Malay Peninsula, has duller coloring.

Perching Birds—Greatest Group of All

More than half of the 8,600 or so species of birds belong to the huge order of perching birds. There are approximately 5,100 species in this large group. As a rule these birds are small; taken as a whole, they are without doubt the most advanced and successful of all the birds.

The order Passeriformes, as the perching birds are known, contains three main subgroups. In the first, naturalists place only the Australian Lyre-bird, and possibly one or two other peculiar Australian birds.

Then we have the true singing birds (Oscines), and those that have a less elaborate structure of the muscles of the syrinx or voice box. These last, the Clamatores (the noisemakers), seem, by and large, to be a declining group. The Old World representatives—the pittas, philepittas, broadbills, and New Zealand "wrens," are apparently getting along best on islands such as Madagascar, New Zealand, and the East Indies. The headquarters of the Clamatores is South America, but that continent was isolated for many millions of years from the other continents and has rather primitive animal forms. On the other hand, we find that some of the Clamatores—notably the Tyrant Flycatchers—have invaded North America in considerable numbers.

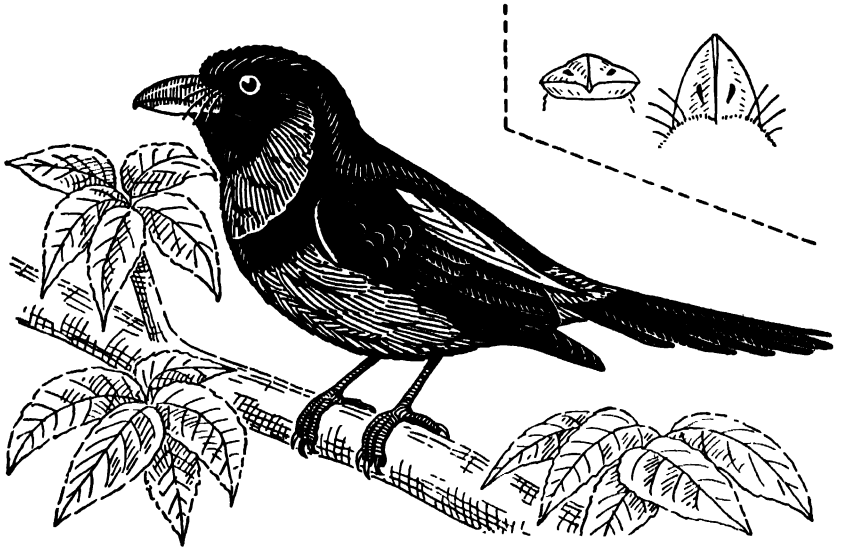
The Oscines or true songbirds number about four thousand species. Well represented in almost all parts of the globe, they seem to be at their most varied in the Old World tropics.

BROADBILLS—AMONG THE HANDSOMEST OF ALL BIRDS

These birds have an unusually broad bill which they use to catch insects on the wing. Though you would gather from this method of

feeding that they are active creatures, the reverse is true—they are rather sluggish. However, most broadbills are very beautiful, with reds, blues, and greens predominating in their plumage. These primitive perching birds (family Eurylaimidae) build large, hanging nests with a side entrance. They are best represented in the East Indies, though a few range as far as the Himalayas, and two are found in Africa.

The Green Broadbill, *Calyptomoena viridis*, is bright green with black spots on the sides of the head. The forehead feathers are very dense and extend forward over the bill. Two related species, found only in the mountains of Borneo, are among the prettiest of all birds. One of them has green plumage streaked with black; the other is green above, blue below.



A SLUGGISH BUT BEAUTIFUL BIRD

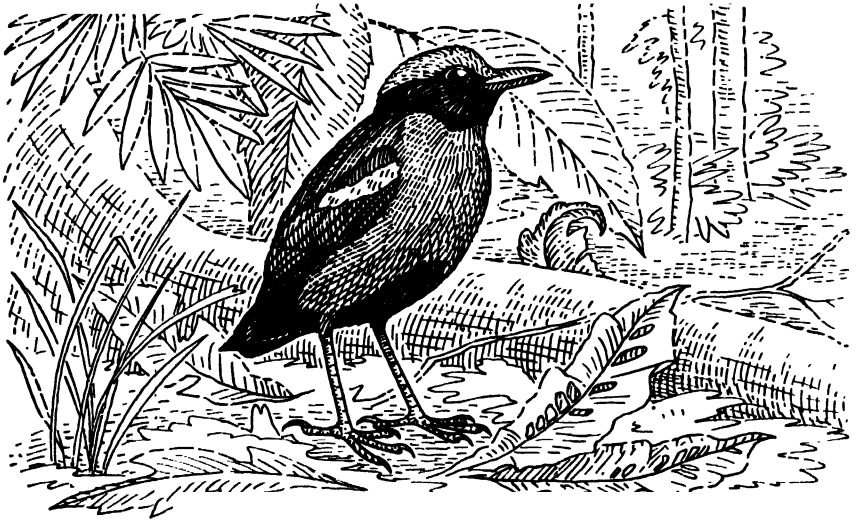
The magnificent black and red broadbill dwells in the jungles of Indo-China and the great islands of the East Indies. Its capacious bill makes short work of large insects and wild fruit. Like other broadbills, this bird is at most times a rather sluggish creature.

On the other hand, the Common African Broadbill, *Smithornis*, is a plain-colored bird. It has a curious courtship performance, in the course of which the male makes a short circular flight above its perch and produces a whirring note with its wing quills. The other African Broadbill, *Pseudocalyptomoena*, is a bright-colored little bird

found only in the mountain forests of central Africa. At one time naturalists considered both African broadbills members of the Old World flycatcher family. A careful study of the birds proved they were true broadbills.

PITTAS AND THEIR GORGEOUS COLORS

Pittas, also known as jewel thrushes, are among the most beautiful of all the birds. They live on the ground in deep tropical and subtropical forest. We find them at their most diverse and abundant in the Malay countries and the East Indies, but they range as far as Africa, northern Australia, and the Philippines. They hop about on the forest floor, feeding on insects, worms, and snails. When startled, these lovely birds sometimes flutter along on the ground with a feeble, thrashing flight—though ordinarily they make their exit by hopping through the underbrush. The scattered and hidden individuals maintain contact by means of loud, rather plaintive whistles, heard chiefly in the morning and evening. They roost well above the ground, and also sing and whistle from such elevated perches.



THE GREEN-BREASTED PITTA

Noted for its lovely colors, this bird of the deep tropical forest is a poor flier. It maintains contact with its fellows by means of rather plaintive whistles. Its globelike nest, placed in thick undergrowth, has a side entrance.

The twenty-three known species of pittas (family Pittidae) are remarkably alike in structure and habits. All are plump, long-legged birds with comparatively large heads, short, rounded wings, and exceedingly short tails. The New World ant pittas—no relations—are very similar to them in form but not in color.

The more colorful pittas include Steere's Pitta, *Pitta steerei,* a bird of the Philippines with a black head, white throat, olive-green back, and sky-blue wing and abdomen—the latter with a velvety black center. Another striking member of the family is the Superb Pitta, *Pitta superba,* of the Admiralty Islands; it is velvety black with sky-blue wings and a scarlet abdomen. Perhaps the most beautiful of these birds is the Blue-tailed Pitta, *Pitta guajana,* which we find in Malaya, Sumatra, and Borneo. Its vivid colors include a rich brown above with a golden-yellow eye-stripe and hind neck, black mask and central crown, buff throat, purple tail, black and white wings, blackish-purple under parts, and brilliant orange-red chest barring.

Pittas build their nest of twigs, moss, bark, and leaves glued together with mud; the whole forming a globelike structure with an entrance in the side. It is placed on or near the ground in thick undergrowth. The female lays three to six whitish eggs peppered with purple, brown, and red.

PHILEPITTAS—PRIMITIVE BIRDS

You have noticed in a number of earlier cases that birds dwelling on large islands are likely to include some primitive types. This observation applies to the philepitta, found only on Madagascar. It is a quiet bird of the forest undergrowth, where it lives on fruit. The Common Philepitta has smooth black plumage, and the male sports large wattles on the head. The philepittas make up the family Philepittidae.

Two other Madagascar birds (belonging to the genus *Neodrepanis*) used to be placed in the sunbird family. These birds are highly modified for sucking nectar from flowers; they have a curved bill for the purpose, and that was why naturalists included them among the sunbirds. Recent study has shown, however, that the birds are really philepittas.

MANAKINS AND THEIR COURTSHIP DANCES

We once watched the Redheaded Manakin, *Pipra mentalis,* dance on a specially coveted limb thirty feet above the ground in a forest tree in Panama. The hard-working little fellow remained on and about his *lek* (courtship area) day after day, snapping his wings like an infuriated crapshooter at the modestly dressed females and doubtless luring some of them to tryst with him on his prepared courting stage. Thereafter the female manakins were left strictly to their own devices. Theirs was the responsibility of building the nest, incubating the eggs, and bringing up the young.

These manakins, dwellers in the American jungles, are sparrow-sized birds. The males of many of the fifty-nine species—the whole group makes up the family Pipridae—are brilliantly adorned in crimson, blue, and gold. Others, however, are dressed in the most inconspicuous of forest colors—dull olive or gray. And, as you would expect, these dull hues apply to the female manakins in general.

The typical manakin is a stocky bird with a short bill, weak legs, square tail, and curiously compressed wing bones; while the oddly formed quill feathers arising from the forearm have thick shafts. The shape of the wing bones and feathers is a key to the noise-making of the voiceless manakins—the explosive rattling and snapping of the wings. These sounds, produced during the breeding season, take the place of song in attracting a mate or warning off other males.

Gould's Manakin, *Manacus vitellinus,* of Central America, a four-inch bird, performs a very specialized courtship dance complete with elaborate wing-snapping. This bird's *lek* is on the ground. Here the male clears a doormat-sized space of every leaf and twig and guards it jealously. Dressed mainly in green, he has a vivid black crown, and black wings and tail; his throat and the sides of the face are bright orange gold.

Many other manakins are quite striking in appearance, perhaps the most spectacular being the Cirrhate Manakin, *Teleonoma filicauda,* a finch-sized bird with long hairy shafts sticking out one and a half inches beyond the tail. Black above with a scarlet crest, it has a canary-yellow face and under parts. The Lance-tailed Manakin, *Chiroxiphia lanceolata,* is another finch-sized black bird; its legs and crown are scarlet, the back blue. The male Helmeted Manakin, *An-*

tilophia galeata, is sparrow-sized, brownish black with a glistening red helmet. The female is dull olive gray. One of the most unusual species of this brilliantly colored tropical group is the puffy-throated White-naped Manakin, *Manacus candaei,* of Central America. It is black above, yellow below, with a broad white collar and long white extensible throat plumes.

COTINGAS—EXOTIC BIRDS

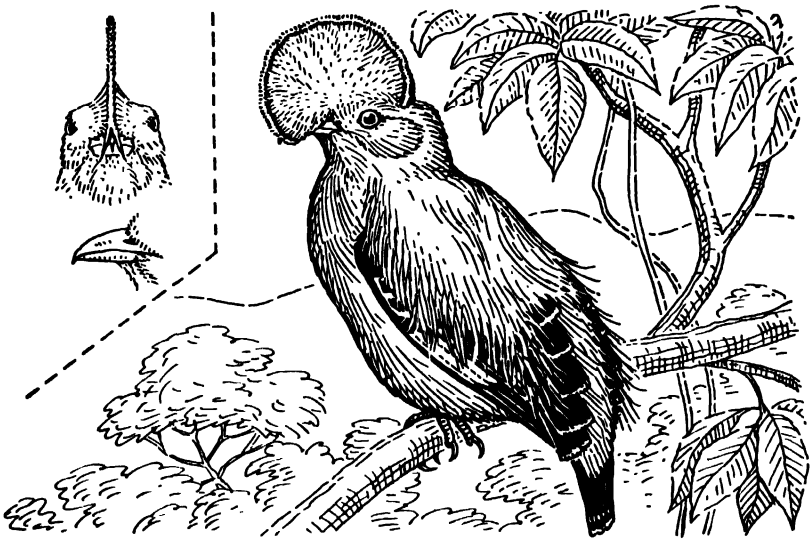
This group of fascinating American tropical birds has three particularly famous members. Each of them is famous for a different feature —one for its appearance, one for its voice, and one for its courtship habits. Most of the ninety species of cotingas have attractively colorful plumage. Ranging from wren to crow size, they are frequently dressed with peculiar and bright accessory plumes, and marked with patches of blazing color. The queer-looking Umbrella Bird, *Cephalopterus ornatus,* does not fit into this picture at all. This name is a puzzling one, but, as you will see, it is appropriate. The umbrella bird is a crow-sized, bluish-black species with a tremendous extensible crest. When this crest is opened, it covers the crown and bill completely, taking on the appearance of a shaggy parasol. One species has a nude reddish chest, with a long, tassel-like wattle dangling from it.

The Bellbird, *Procnias alba,* of northern South America, is another famous member of the group. Again the name may puzzle you, and again it is apropos. This bird has an amazing bell-like voice that makes it the most conspicuous forest bird in South America. A rope-like black wattle on the forehead is lashed about the bill as this remarkable bird delivers its penetrating call from a high perch over dense forest. High on Mt. Auyantepui in southern Venezuela we once heard a marvelous bellbird chorus ringing out about a thousand feet below us and perhaps a mile away.

Another feature that helps make the bellbird the most noticeable bird of the forest is its spotless white plumage. The Ghost Cotinga, *Carpodectes nitidus,* a bird we found in Central as well as South America, has the same kind of plumage. In both cases, the females are smaller and protectively colored with green.

The other outstandingly remarkable cotinga is the Cock-of-the-Rock, *Rupicola,* a parrot-sized golden bird with black wings and an amazing disklike crest. Cotingas are related to the manakins, and

have similar courtship ceremonies. The larger size of the males, and their bright coloring and fancy accessory plumes, are all indications that the female undertakes much or all of the nest-building, incubation, and care of the young. It is probable that many species of cotingas are polygamous.



THE COCK-OF-THE-ROCK AND ITS COURTSHIP DANCES

One of the most bizarrely plumed of South American birds, the cock of the rock is also noted for its courtship dances. At courting time, about twenty males and females gather on and near the ground to perform noisy mating displays in special forest arenas. The inset shows (*top*) how the permanently erected crest covers the bill and (*bottom*) what the bill looks like without the crest.

In a family noted for its elaborate courtship dances, that of the cock-of-the-rock is the most famous of all. Explorer Robert Schomburgk tells of observing about twenty of these birds of both sexes perched on bushes surrounding an open space on the ground, all of them uttering cries. One male with wings and tail outspread was on stage. He walked in circles, scratching the ground, moving his wings up and down. Finally he jumped to the sidelines, apparently exhausted, as another male took his place in the ring. Schomburgk reports that the females kept calling all the while, but remained on their perches. Some cotingas carry on their courtship on the ground, others high among the branches.

Nesting methods vary also. Some species—the umbrella bird for one—build nests of sticks in tall trees; others construct hanging nests, a few make use of tree cavities, and at least one bird, the cock-of-the-rock, nests in caves. In southern Venezuela, in 1937, we found a nest of this bird on a ledge five feet above the ground in a large, dimly lit cave. It was built of mud and twigs and finely lined with black rootlets. On the floor, below the nest, were many olive-sized nuts which the birds had stripped of their fleshy husks. The eggs of this species are buff with reddish-brown and violet spots; the umbrella bird's are pure white.

Cotingas—they make up the family Cotingidae—dwell in the upper levels of the forest where they can find fruit, berries, and insects. These birds usually have harsh voices—the bellbird is an exception—and some of them, like the Capucine Monkbird, *Perissocephalus tricolor*, have a garrulous, explosive grunt reminding us of a howling monkey's. Incidentally, this aptly named pigeon-sized, cinnamon-brown cotinga has a nude bluish-gray head surrounded by a collar of bulging feathers, giving it the look of a rotund old monk with his head pulled in. Large cotingas of peculiar form are the Crimson-fruit Crows, *Haematoderus militaris*, of northern South America, which are strawberry red throughout. Another group of strange-looking birds are the Wattled Bellbirds, *Procnias tricarunculata*, of Central America; reddish with a white head and throat, they have three black, whiplike wattles springing from the base and sides of the bill.

As for the small cotingas, six to ten inches long, naturalists call them the true cotingas. Many are brightly colored, though some are grayish and nondescript with no distinction in color between male and female. A notable example of the colorful birds is the Pompadour Chatterer, one of the most exotic of the cotingas. This name was gallantly bestowed on it by an English ornithologist named Edwards, who named the gorgeous creature in honor of a famous French siren of his day, the celebrated Madame de Pompadour. One of these birds was being shipped to her when it fell prize to a British frigate.

The male Pompadour chatterer is a glistening raspberry red with hairlike feathers, twisted wing coverts, and spotless white wings. Females and immature males are gray below and slate above. An inhabitant of the forest crown, it ranges over much of South America. We found it to be rare in southern Venezuela.

The Common Gray Cotinga, *Lipaugus vociferans,* is doubtless the commonest and the most inquisitive of tropical forest birds. Robin-sized and gray, it follows the hunter tirelessly, and seems always to dart into sight whenever a disturbance occurs. The only cotinga to reach the United States is the Rose-throated Becard, *Platypsaris aglaiae,* which we find occasionally in southern Texas and Arizona. It builds a large, untidy, baglike nest.

TYRANT FLYCATCHERS

Tyrant flycatchers are literally tyrants in their relations with other birds. Aggressive and pugnacious, they do not confine their attacks to birds their own size, but readily tackle hawks, crows, and other large birds. As for the "flycatcher" part of the name, it tells you how these birds get their living—they feed on flies and other insects. Selecting a prominent perch, the flycatcher sallies forth in pursuit of a hapless insect, seizing its victim with an audible snap of the broad, flat bill.

An interesting point about these tyrant flycatchers is that of the many families of primitive perching birds that abound in South America, the flycatchers are the only ones that have ranged northward and become an important part of the birdlife of temperate North America. Even so, the great majority of the 365 species of this large family (Tyrannidae) are native to tropical America.

KINGBIRDS—NO RESPECTERS OF HAWKS

Woe betide any crow or hawk that approaches the kingbird's nest. Uttering a high-pitched battle cry, the kingbird sets out in hot pursuit, swooping down again and again to strike its larger but clumsier adversary on the back and shoulders. Finally it returns triumphantly home with short, quivering wingbeats. Even humans who venture to climb to its nest are given the same unceremonious reception, and have been known to fall from a tree when taken aback by the fury of this starling-sized bird's onslaught.

The Eastern Kingbird, *Tyrannus tyrannus,* is common in eastern North America during the summer; in the winter, like other northern members of the family, it migrates to tropical climes where it can find insects on the wing. Grayish black above and white below, the kingbird has a white-tipped tail, and on its crown there is a concealed red patch.

THE PHOEBE AND ITS RELATIVES

Of far gentler demeanor than its cousin the kingbird is the familiar Phoebe, *Sayornis phoebe.* Its name comes from the throaty note it utters incessantly during the nesting season. A somberly colored bird of sparrow size, it has a brownish-black back and a black head; the under parts are grayish white.

This flycatcher likes to nest near water, attaching its feather-lined nest of mud to a niche in a rock wall or steep river bank. Now that it has learned to use man-made structures, you may sometimes find its nest on a beam below a bridge or on the rafter of an outbuilding. It lays four or five white or lightly spotted eggs.

The Wood Pewee, *Contopus virens,* is similar to the phoebe but it lives in woodlands and has a much mellower song, "Pee-a-wee" according to some, "Dear me, dear me" according to other listeners. The wood pewee is a notable nest builder, its nest being a dainty cup placed on a lichen-covered branch. The bird covers the outside of this structure with lichens attached by spider webs. The finished nest takes on the appearance of a knot or protuberance on the branch.

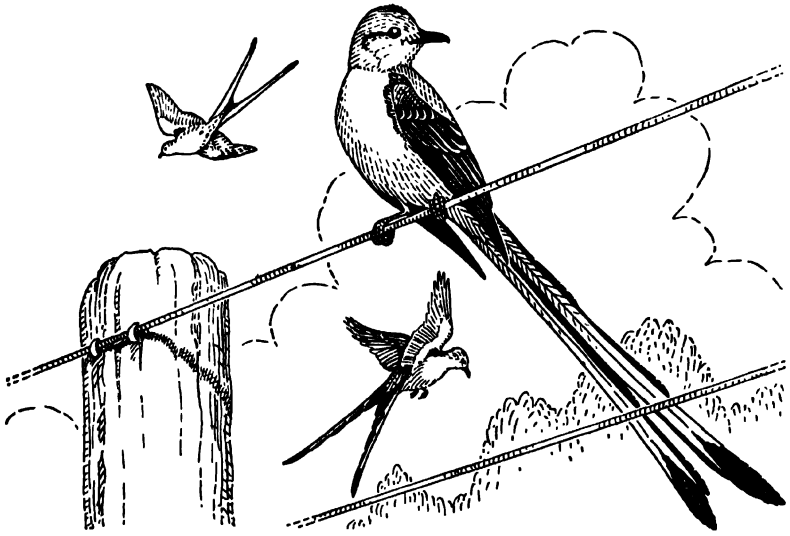
As for some of the other North American flycatchers—the Alder and Acadian Flycatcher, for example—many find it difficult to tell them apart, or even to distinguish them from the pewee and the phoebe. However, once you become familiar with their songs and habits, you find that each of these birds is quite distinctive.

CRESTED FLYCATCHERS—THEY USE CAST-OFF SNAKESKINS

The Crested Flycatcher, *Myiarchus crinitus,* is noted for its habit of usually including a castoff snakeskin in its nest. We do not know what purpose, if any, this curious trait serves; but some naturalists believe that the snakeskins scare away enemies that intend to rob the nest. Nesting in holes in trees, the crested flycatcher lays eggs marked with irregular black lines. It is in eastern North America that we find this bird, which has relatives in the southwestern United States and in tropical America as well. A grayish-brown bird with chestnut on the wing and tail quills, it utters loud mellow notes that immediately attract our attention.

ATTRACTIVE SOUTHWESTERN FLYCATCHERS

Most flycatchers have dull colors, but the Scissor-tailed Flycatcher, *Muscivora forficata,* which we find in Oklahoma and Texas and nearby areas, is one of the exceptions. It is gray, white, and buff, washed with delicate pink on the breast. The deeply forked tail is a good ten inches long. The scissortail is an interesting bird to watch. You may see it select a perch on a fence post beside some well-traveled road, opening and closing its streaming tail feathers like a pair of scissors, or dashing off in graceful pursuit of insects.



A TYRANT FLYCATCHER

The scissor-tailed flycatcher, like all the tyrant flycatchers, is an expert at catching flies and other insects. They are called "tyrants" because of their pugnacious nature. These birds make a practice of attacking other birds—some much larger than themselves. In flight, the tail feathers of this flycatcher open and close like a pair of scissors.

The gorgeous Vermilion Flycatcher, *Pyrocephalus* ("fire-head"), dwells in only one section of the United States—along the Mexican border in the Southwest. The male's entire head and under parts are vermilion, immediately catching your eye amidst the desert vegetation. Its fluttering, butterfly-like courtship flight is a thing of beauty.

TROPICAL FLYCATCHERS—INCLUDING A FREEBOOTER OF THE SKY

As we have seen, northern flycatchers vary quite a bit in their nesting habits. The southern ones have exploited still other possibilities. A Panamanian flycatcher, *Legatus,* is fond of nesting in the long swinging nests of the large tropical orioles or oropendolas. Instead of merely contenting itself with an old nest, this flycatcher, with the belligerence we have observed in the family Tyrannidae, constantly badgers and chases the much larger oropendolas until they abandon their nests to their tormentor. Thus the nest becomes the flycatcher's booty.

SHARP-BILLS—MYSTERIOUS BIRDS OF THE TROPICAL FOREST

The Sharp-bill, *Oxyruncus cristatus,* is the only species in this South American family. Though closely related to the flycatchers, sharp-bills differ by having a straight, sharp bill which is not hooked and fringed with hairlike plumes. They live in the upper tier of thick tropical forest, and we know little of their habits aside from the fact that they are sometimes found in the company of small tanagers. Sharp-bills—the family name is Oxyruncidae—are yellowish green above with a glossy red (usually concealed) crest. The under parts are gray to yellow with much bold black spotting.

ANT BIRDS—HOW THEY RELY ON THE ARMY ANTS

In our quest for birds for scientific purposes in the forests of tropical South America, we learned to seek out roving columns of army ants by the peculiar noises they create. Each such column is usually made up of hundreds of thousands of running ants which flow in a blackish carpet over the forest floor, scanning every burrow, every leaf, and ascending every twig, bush, and tree.

To stand in the path of an approaching army, even when the advance patrols are still far off, is an experience that you are not likely to forget soon. You can see every kind of insect and spider fleeing for its life. Millipedes come to the surface, spiders slide stiffly down their silken shrouds to the ground. Countless kinds of insects patter on the

dry leaves like rain, once they have made a panicky leap from a high perch. These creatures flee well in advance of the marauding ants that force all laggards to walk the plank to their death amidst the swirling mob below.

It is through this maelstrom of death that the ant wrens and ant shrikes weave their sprightly way. Calling shrilly, twittering and darting merrily about, they gorge themselves on the hapless insects, keeping always just ahead of the carpet of ants.

Next to hummingbirds, these ant birds are perhaps the most characteristic and abundant forest birds of the American tropics. Naturalists know of no less than 238 species of these birds; the family name is Formicariidae. Among ant birds, there is often a distinct difference in the appearance of the sexes—the male black and white, the female brown or gray. Quite a few have a concealed whitish spot on the back. Ant birds generally build crude hanging nests in low positions in deep forest. They construct their nests of fibers, roots, a few leaves, moss, and grass. The female lays two or three white, blue, or brownish eggs, usually boldly blotched or scrawled with bright brown or gray.

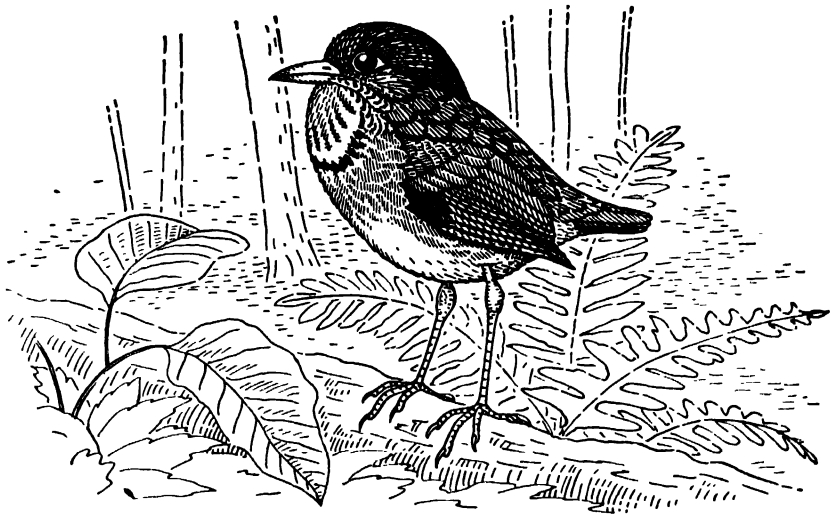
ANT SHRIKES, ANT WRENS, ANT THRUSHES

Naturalists recognize three main groups of ant birds: ant shrikes, ant wrens, and ant thrushes (ant pittas). Ant wrens, the most abundant members of the family, live on or near the ground in deep jungle. They have a rather slender, moderately hooked bill, and a warbler-like tail. Traveling in groups, they are easily observed. They spend much of their time in the company of ant shrikes and wood hewers. These mixed parties, often totaling twenty birds of four or five species, are very noisy and their twittering notes can be heard for perhaps forty yards in deep forest. Such a chorus is in reality a battle cry, signifying that a column of army ants is on the move—with what consequences we have already seen.

Ant wrens vary a good deal in size and coloring, but all are rather slender birds. The tiny Amazonian Ant Wren, *Microrhopias quixensis*, a warbler-sized bird, is black with white spots on the wings, tail, and bases of the back feathers. The female is dull brown. The Pied Ant Wren, *Melanopareia maximiliani*, a long, typically slender bird about the size of a large warbler or wagtail, has a bright reddish

breast with a vivid white throat, a black mask, and grayish upper parts.

The ant shrikes, which have a compressed and strongly hooked bill, live in the lower and middle tier of the tropical forest or forest edge. In the larger ant shrikes the bill is usually deeply notched. The White-barred Ant Shrike, *Thamnophilus doliatus,* a bird we find in Mexico and northern South America, is amusingly dressed like a convict in vivid black and white bars. This stocky starling-sized bird has a relatively long tail and a white crown, while the female is reddish brown though similar in form. The White-winged Fire-eye, *Pyriglena,* a bird of the Andes from Colombia to Bolivia, is velvety black with concealed white on the wing, and wine-red eyes. The most com-



THE SPOTTED ANT PITTA

The ant bird has one of the most interesting feeding techniques known in the bird world. When a column of army ants is on the move in the South American jungle, every conceivable kind of insect and spider flees from the approaching horde. At such times the ant bird makes its appearance and gorges itself on the panic-stricken insects.

ical of ant shrikes is the White-faced Ant Bird, *Pithys albifrons,* of South America. A sparrow-sized bird with a reddish-brown body and grayish wings, it has a goatlike beard and a great shaggy forehead crest, both of which are pure white. It travels in large, compact flocks near the jungle floor.

We come now to the last of the three main groups of ant birds—

the ant thrushes, or ant pittas, as they are sometimes called. Thick billed birds living on the floor of deeply shaded forest, they often resemble large brownish thrushes with greatly elongated legs and very short tails. They are secretive creatures, among the shyest and most retiring of all birds. Yet, like the rails, they utter loud, repetitious calls. Usually found alone or in pairs, ant thrushes have a call consisting of an oft repeated hollow whistle delivered most frequently at dawn and dusk. This whistle has an exasperatingly ventriloquial quality—nature's device to aid the bird in hiding from its enemies.

We have spent numberless hours hunting the deep forests for these rare birds, and on several occasions have glimpsed some that are apparently still unknown to science. One of these, on the plateau of Mt. Macarena, in southeastern Colombia, seemed to be whistling at our very feet, yet we failed to catch more than a fleeting view of it. It is not too difficult to give a fair imitation of the whistling note, and in this way it is sometimes possible to draw the bird from its deep retreat. Under ideal circumstances it will suddenly appear out of nowhere on the top of a rock or log, perch there stiffly for a few moments—and then vanish for the day.

A typical member of this secretive ant thrush or ant pitta group is the Undulated Ant Pitta, *Grallaria squamigera,* a bird native to the northern half of South America. It has legs two and one-half inches long (more than twice the length of its stubby tail), a plump olive body, bluish-gray crown, and pale cinnamon under parts barred with black. Like its relative *Grallaria excelsa*, of the Venezuelan and Colombian Andes, this species dwells on the floor of thick, subtropical mountain forest, often at altitudes of as much as eight thousand feet.

OVENBIRDS—FEATHERED MASONS

These inconspicuous birds of the American tropics are remarkable for one trait—their flair for nest-building which gives them their curious name. As masons they have few equals among the birds. Their ovenlike nests are built of a variety of materials—mud, twigs, sticks, leaves, and grass. Usually these elaborate structures contain an inner chamber reached by a circular passageway from a side entrance.

Some kinds of ovenbirds commonly nest about houses, placing their mud nests (which weigh five to ten pounds!) on posts, beams of sheds, and on low, flat limbs. One of these birds, the Pale-legged

Ovenbird, is somewhat smaller than a starling, with a pale ochraceous back, wings, tail, and chest, a dark-brown head with broad white eye-stripes, and whitish under parts.

These birds are desirable, cheery neighbors to have about the garden. Whenever ovenbirds place a nest within view of a house, they put the side entrance toward the house; thus, their entertaining comings and goings are easily observed. To complete one of these elaborate constructions often costs the birds several months of intermittent work. The nest, formed of vegetable fibers and mud, becomes hard and adobe-like on drying. The female lays three or four white, cone-shaped eggs in the inner chamber, which is usually lined with grass. The male assists in incubating. The birds build a new nest each year —sometimes on top of the old structures.

Ovenbirds (they make up the family Furnariidae) are generally reddish or cinnamon, and have a soft and usually square tail. They are catholic in their choice of surroundings for their living quarters. Some, as we have seen, place their nests quite close to houses. You may find others in open orchards near human habitations. Some ovenbirds dwell on the floor and middle tiers of deep forest, some on the banks of tropical and mountain streams. Some are grass dwellers, some reach the temperate zone on high mountains.

In northern South America the species most frequently encountered is the shy *Synallaxis*, a warbler-sized reddish-brown bird with soft plumage and a long soft tail. It is usually found in quiet pairs in the lower portions of thick second-growth forest. Building a bulky nest of twigs, leaves, feathers, and grass in low trees or bushes, it deposits three or four whitish or pale-blue eggs. Although it is built of light materials, the nest has the characteristic ovenlike construction.

The Sharp-tailed Creeper, *Lochmias nematura*, which dwells in the mountains of South America, is a bird of wrenlike habits. We found it living in rocky gorges on the plateau of Mt. Auyantepui in southern Venezuela, at seven thousand feet above sea level. Whenever we encountered this bird, it was always very close to swift-flowing water. Somewhat smaller than a sparrow, this creeper is chocolate brown with long, slender legs. Its under parts are distinctively whitish with vivid brownish-black scalloping. Unlike the general run of ovenbirds, the sharp-tailed creeper has a stiff tail, very much like a wood hewer's. For this reason some naturalists prefer to unite the two families.

The most untypical of the ovenbirds is probably the Colombian

"Xenops," *Xenops minutus.* Resembling a tiny wood hewer or creeper, it has reddish-brown plumage above, and grayish brown below. The feathers of the head and throat have white oval centers.

WOOD HEWERS—CREEPER-LIKE BIRDS

These birds have a deceptive name. You might gather from it that they chop into wood in the manner of woodpeckers. This is not so; wood hewers use their bill to pick insects from crevices and holes in bark. Wood hewers spend much of their active time creeping about in trees, and are adapted for this in a number of ways.

These brown, creeper-like birds dwell in the tropical forests from Mexico to Argentina. Most of them are five to eight inches long. Of the sixty-three known species—they comprise the family Dendrocolaptidae—a few are wren-sized, while a small number attain the size of a dove. The wood hewer's tail is long and stiff with spiny tips. These serve to prop or brace the bird as it creeps about, head up, on vertical tree trunks in quest of food.

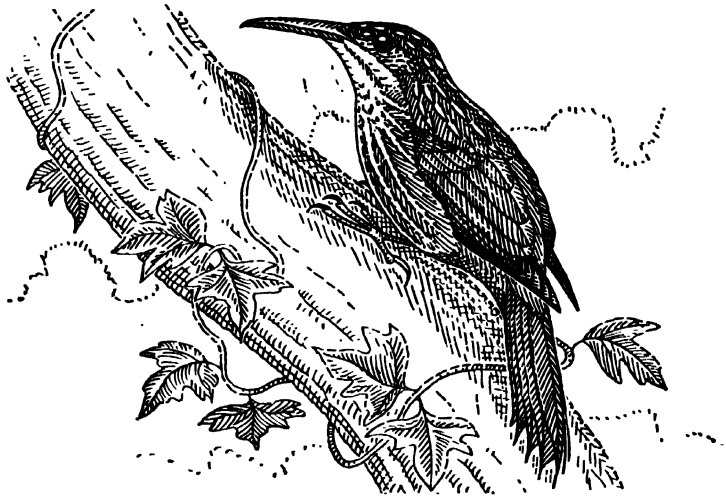
The bill is generally long, slender, and gently curved, but in several species it is sickle shaped, or small and chisel-like. The wood hewer with the most spectacular bill is the Sicklebill, *Campylorhamphus trochilirostris.* It uses its long, slender bill like a pair of forceps to pick insects from deep crevices in bark or in the axils of long leaves. As you would expect in a tree-climbing bird, the wood hewer has long toes and sharp claws.

Wood hewers, as we have seen, feed on insects and take their eggs from crevices in bark and termite nests. They hunt creeper-like on tree trunks, hopping upward from the base, usually in a spiral path, then fluttering downward to the base of a neighboring tree. Smaller species may hunt only in high limbs or on high portions of the trunk. Wood hewers nest in cavities in forest trees sometimes less than a foot from the ground. Two pure-white eggs are laid. Some wood hewers sing beautifully.

Almost all wood hewers are reddish brown or tan above, brighter on the tail, and more buffy on the under parts. Often they travel and hunt with ant birds, one or more almost always being present when a congregation of birds assembles to attack insects fleeing a column of army ants. At such times there is much twittering and excitement as

the wood hewers and other birds flutter about in the lowest tier of the forest.

Although most wood hewers live entirely in trees, one species, the Patagonian Earth-creeper, *Upucerthia dumetaria*, spends a good deal of time on the ground. A pale-brown bird, it has a long, curved bill, a long, soft tail, a whitish face, and buffy under parts.



THE WOOD HEWER DIGS OUT INSECTS

The wood hewer creeps about on trees in search of insects. It has a bill adapted for picking insects and their eggs out of crevices in bark. Like the woodpecker, the wood hewer has strong toes suited for gripping tree trunks, and a stiffened tail which it uses as a prop. Wood hewers make their nests in tree cavities.

TAPACULOS—SHY BUT VOCIFEROUS

The name "tapaculo" is Chilean. A word of Spanish origin, it alludes to the seeming immodesty of these cocky little birds as they strut about with tail erect and hind parts exposed.

Tapaculos are inconspicuous little birds that fly rarely, preferring to scurry rodent-fashion on the shadowy forest floor. Some species dwell on grasslands, but the great majority are at home in wooded areas. We find the twenty-eight kinds of tapaculos between Costa Rica and Patagonia—some of them to elevations of ten thousand feet

in the Andes. They comprise the family Rhinocryptidae. All are very shy and, but for their habit of scolding and following intruders, it would be extremely difficult to observe them.

Most tapaculos are dark slate or brown above, gray or buff below, with straight bills and scalloped plumage. They usually place their nest, constructed of sticks, grass, and moss, near the ground in a bush.

The Rufous-vented Babbler or Tapaculo, *Scytalopus femoralis*, is the size of a large wren and similar in general form. It is a blackish-brown bird with narrow reddish scalloping. The most highly specialized tapaculo is the quail-sized Ocellated Babbler, *Acropternis orthonyx*, which has a curiously flat bridge to its rail-like bill, and tremendously elongated hind nails. It is reddish brown with black body plumes, each with a solitary round white spot.

ANT PIPITS

The dozen or so species of this family are short-tailed, long-legged birds, very similar in appearance and habits to some of the ant birds. The ant pipits are all denizens of jungle undergrowth in the American tropics. These birds are usually gray above, whitish below with a white eyebrow of lengthened feathers and a black or chestnut cap. They differ in some respects of body structure from the ant birds; that is why they are placed in a separate family, the Conopophagidae.

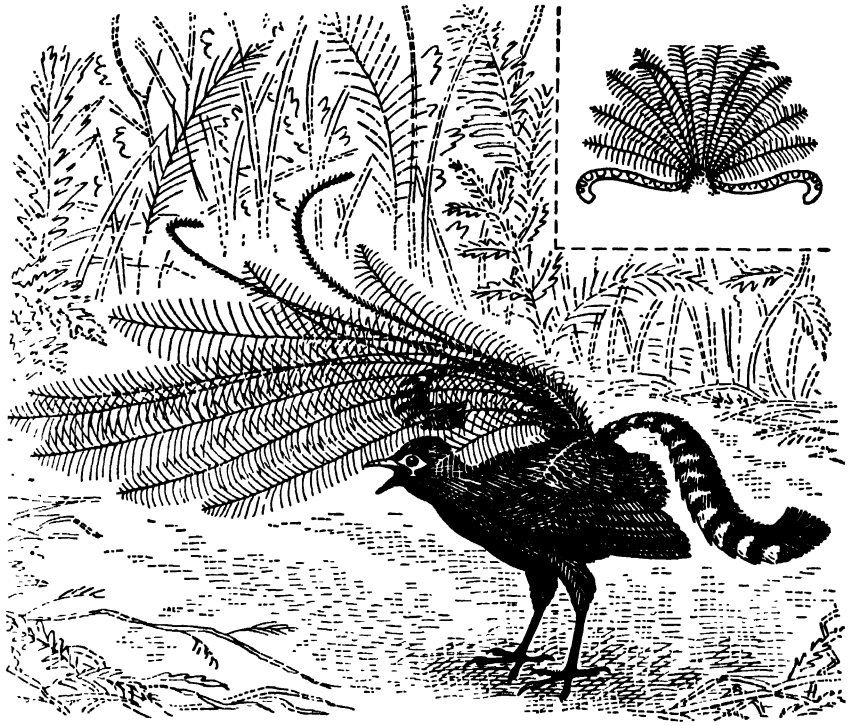
LYREBIRDS—THEY CAN IMITATE AN AUTOMOBILE HORN

Australia has many candidates for the title of the world's strangest bird. Perhaps the most unusual of the lot is the Superb Lyrebird, *Menura superba*. The cock lyrebird is a remarkable vocalist and can imitate a great many birds—and even such sounds as the honk of an automobile horn. But this bird will amaze you even before it utters a sound, for it has long lyre-shaped outer tail feathers fully two feet long. These plumes are whitish marked with V-shaped areas of deep umber brown. The whitish central tail feathers have a filmy, lacelike structure.

This magnificent tail has considerable courtship value, and the male lyrebird knows how to make the most of it. He builds an unobstructed moundlike display area on the forest floor. Then, to attract a mate near his mound, he spreads his tail to the utmost and brings

it forward so that the feathers extend over his head, meanwhile calling and singing.

The nest of the lyrebird is a large, globular affair. The single heavily marked egg takes five weeks to incubate, and the development of the young is correspondingly slow.



THE LYREBIRD AND ITS EXTRAORDINARY TAIL

Famous for its amazingly beautiful tail feathers (their lyre shape is shown in the detail), this Australian bird is a great mimic. Observers credit it with being able to imitate the honk of an automobile horn. The lyrebird, by the way, is the largest of all the perching birds. The male shows off on a "stage" from which he has removed all forest litter.

About the size of a rooster, the lyrebird was grouped with the pheasants by early explorers because of the structure of its head and bill and its strong legs. Later on, naturalists realized that the lyrebird was a very unusual member of the order of perching birds. In fact, it is the largest bird of the order. The only other member of the lyrebird family (Menuridae) is Albert's Lyrebird, *Menura alberti,* which lacks the beautiful tail plumes. The family has no close

relatives, though the rare little Australian Scrubbird, *Atrichornis,* is similar in some ways.

SCRUBBIRDS—ANCIENT AND NEARLY EXTINCT

Living in some of the densest scrub and brush in Australia, the scrubbirds hide and skulk so well that it is almost impossible to make them fly. The birds have a very loud voice, said to be ventriloquistic. One of the two species is probably extinct, and in fact this apparently ancient group (family Atrichornithidae) is nearing complete extinction. Scrubbirds look like wrens, but they have several peculiarities of structure, such as the lack of a furculum ("wishbone").

LARKS—ECSTATIC SONGSTERS

The lark has had perhaps more recognition from the poets than any other bird. We all know Shakespeare's "Hark! hark! the lark at Heaven's gate sings," and Coleridge likened the lark's performance to the singing of "an angel in the clouds." There is good observation as well as imagination in these descriptions, and for this reason: The lark is partial to open country and, since it lacks an elevated perch from which to sing, it mounts high into the air to pour forth its ecstatic songs.

The seventy-five species of larks make up what is primarily an Old World family, the Alaudidae. In fact, only one of them, the Horned Lark, *Otocoris alpestris,* has become firmly established in America. Like other larks, it favors open country and is therefore more common in the west than in the east—though even in the east it has become more abundant since the clearing of the forests.

The colors of the horned lark blend with soil and sand. Observe it at close range, however, and you will see that it is a pretty bird with a black collar and a yellow stripe over the eye; the back is suffused with pink. The "horns" are two little tufts of black feathers on the forehead—but these are rarely visible.

The most famous songster of the family is of course the European Skylark, *Alauda arvensis,* but the horned lark is not much inferior to it as a vocalist. Larks lay four or five mottled grayish eggs in a simple grass nest on the ground. Like many other ground birds, larks run rather than hop.

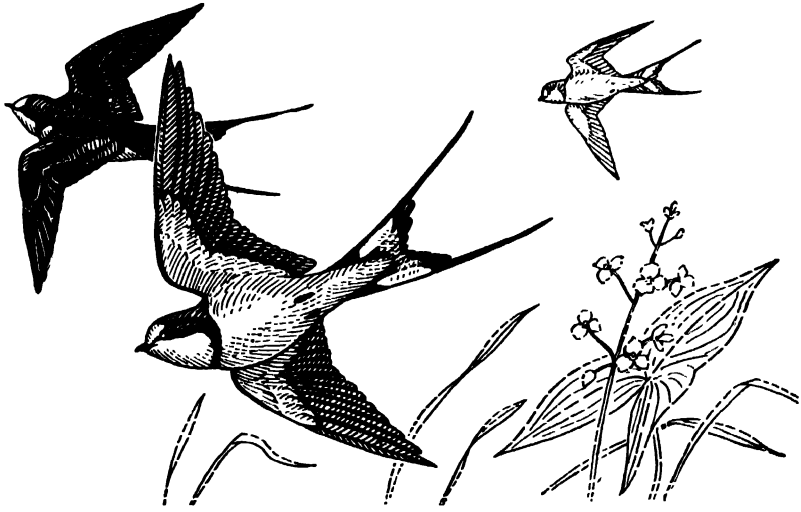
OLD WORLD LARKS

A brownish-streaked species, the celebrated skylark has a modest garb not at all in keeping with its ranking as a songster. Widely introduced into America, it has failed to survive there, though for many years it was possible to find a few of these birds on Long Island, New York.

Many desert larks are protectively colored. Where the soil is reddish, the larks have a similar color—the same feature applies for blackish, brown, or gray soils. This adaptive camouflage is the lark's chief resource against attacks by hawks in deserts or grassy plains where there are no bushes or other cover.

SWALLOWS—GRACEFUL, FRIENDLY AND USEFUL

Swallows are among the most attractive of all songbirds. Their flight is a byword for gracefulness as they carry on their almost incessant pursuit of flies and other insects. When the farmer mows his hayfields he is often accompanied by a group of swallows, swooping back and forth above the cutter bar to catch the insects as they are disturbed in



THE BARN SWALLOW—MAN'S FRIEND

Though it formerly nested on rocks, the barn swallow generally builds its nest nowadays on the walls of buildings. Like all swallows, it captures a great many insects in the course of its graceful flight. This seven-inch songster is among the tamest of wild birds.

flight. These birds have a short, flat bill with a broad gape that enables them to get the most insects for their exertions.

Over much of the United States the best known of the swallows (there are seventy-five species in the family Hirundinidae) is the Barn Swallow, *Hirundo rustica,* or Common Swallow as it is called in the Old World. Like all the other swallows, it has very small, weak legs and feet—it can perch well but rarely attempts to walk. The back of this beautiful bird is glistening bluish black, the breast reddish, and the long, forked tail is ornamented with white spots.

Once the barn swallow nested on cliffs, but now it almost invariably makes its home on ledges or on beams of barns or other buildings. Thus the barn swallow is man's friend not only because of the large quantities of insect pests it consumes, but also because of its nesting habits. The nest itself is made largely of mud and can be plastered onto any convenient wall so long as some slight support is available. After lining the nest with feathers, usually obtained from some nearby chicken yard, the barn swallow lays four or five white eggs spotted with cinnamon brown. The birds often rear two broods in a single season, and they may use the same nest year after year. Their song is a musical twittering, especially pleasing when uttered by several swallows in unison as they snuggle side by side on a beam to enjoy the first warming rays of the morning sun.

The Cliff Swallow, *Petrochelidon albifrons,* has also learned to nest on buildings, placing its large mud nests on the outside of barns—just below the eaves where they are protected from rain. Because of this trait it is often called the "eave swallow." A famous colony of cliff swallows has nested for years at the Mission of San Capistrano in California, reappearing each spring with the regularity that inspired the song "When the Swallows Come Back to Capistrano." Sometimes, however, weather changes affect the swallows' selection of a time for migrating. Then the schedule is upset, with the result, as the proverb has it, that "one swallow does not make a summer."

Cliff swallows build their homes in the form of large globular balls of mud with a spoutlike entrance on the side. In the West, where this bird still nests on cliffs in the less settled regions, enormous numbers of these mud-balls are sometimes found grouped tightly together on a cliff or steep river bank. You can easily identify the cliff swallow by a large orange spot on its lower back.

Another swallow that likes living in groups is the Purple Martin, *Progne subis.* Some people build large apartment-type birdhouses to provide a home for the martins, but unless a vigilant watch is kept, the birds are often turned out by those quarrelsome pests, the English sparrows. The purple martin, which is, by the way, the largest American swallow, is dark purplish blue.

Most Prefer to Migrate. Entirely dependent on flying insects for food, most swallows are highly migratory. However, they travel by day rather than by night as do many small birds. Their complete disappearance during the colder months accounts for a number of folklore beliefs—that they pass the winter in hibernation within a hollow tree or in the mud at the bottom of a pond.

One group hardier than most are the Tree Swallows, *Iridoprocne bicolor;* a few of these birds pass the winter even so far north as Long Island, New York. At this time of the year they eke out their diet with bayberries. Glossy steel blue above and shining white below, the tree swallow commands your attention as it skims by. It has a habit of placing its nest in a hollow stub near a pond, though it will readily make use of a birdhouse that is provided for it. When fall comes, immense numbers of tree swallows gather in marshes, or on telephone wires, shortly before they begin their southward journey.

The Rough-winged Swallow, *Stelgidopteryx rufipennis,* gets its curious name from the little file-like projections on the leading edge of the wings. This plain-colored brown species nests in a hole in a river bank. The Bank Swallow, *Riparia riparia,* has similar nesting habits, but unlike the rough-wing it lives in large colonies.

CUCKOO SHRIKES—NEITHER CUCKOOS NOR SHRIKES

The cuckoo shrikes have a deceptive name. They are not closely related to either the cuckoos or the shrikes. It is true that in form and color they resemble some cuckoos, for most of them are slender, grayish or blackish birds, and their plumage, especially among the females, is often barred. The bill is slightly hooked and thus has some resemblance to a shrike's. "Caterpillar birds" might be a better name for these birds, as most of the sixty species of the family Campephagidae have a marked taste for caterpillars.

Among the cuckoo shrikes, the feathers of the lower back are stiff-

ened and bristle-like. They build an open, cup-shaped nest and lay from two to five spotted eggs. Though indifferent songsters, they have loud call notes. Most of them make their home in the tropical regions of the Old World, a few getting as far as the temperate parts of eastern Asia. The three species of *Campephaga* proper dwell in Africa. The males are black with a bright-colored shoulder patch, giving them an appearance that may remind you of the American red-winged blackbird. Another African species, the Lobed Cuckoo Shrike, has small fleshy lobes on the sides of the face. Its plumage is bright yellow.

The largest cuckoo shrikes—those of the genus *Coracina*—are generally jay-sized birds with softly blended patterns of gray, black, and white. In the forested regions where they dwell they invite attention with their loud calls.

We find the Minivets, *Pericrocotus*, in India and bordering countries. They have very bright plumage—red and black or yellow and black are the predominant colors. The Ashy Minivet, *Pericrocotus roseus*, ranges as far north as Japan. In winter it migrates to the Malay countries and the Philippine Islands. At this season the birds congregate in large flocks that keep to the tops of the tall jungle trees.

BULBULS—SOCIABLE AND NOISY

The word *bulbul* comes from the Arabic word for "nightingale," though bulbuls are not noted for melody. Many bulbuls are sociable creatures, found in pairs or flocks, and often the most common birds in the areas where they dwell. Some live in deep forest, usually near the ground, others stick to the middle and upper tiers of original tropical and subtropical forest. Still others frequent grasslands and cultivated areas, often near cattle and human habitations. There are a hundred or so species of these inconspicuous, medium-sized birds that resemble tropical flycatchers. They dwell in the warmer parts of Africa, Asia, and the Oriental region, making up the family Pycnonotidae.

All these birds have a short neck and wings, a long tail, and fine, fluffy feathers on the back and rump. The bill varies quite a bit. It may be short and cone-shaped, elongated and slender, or sharply hooked. Male and female are similarly colored—chiefly dull olive gray

or brown and quite frequently washed with yellow. The bulbul feeds on fruit, berries, insects, and seeds. We are told that the South African Bulbul, *Pycnonotus tricolor,* occasionally becomes so intoxicated from feeding on syringa berries that it is easily captured by hand.

The Yellow-vented Bulbul, *Pycnonotus goiavier,* of the Philippines, Indo-China, and Malaysia, is perhaps the commonest Philippine bird in orchards and brushy areas near human habitations. About eight inches long, it has white eyebrows and brownish upper parts. Below, it is tinted with lemon yellow, particularly on the vent and under tail coverts.

In the more forested areas of the Philippines, the Philippine Bulbul, *Microscelis gularis,* is the most frequently encountered bird and, despite its dullish color, the most prominent one. It is very sociable and extremely noisy; though its call notes are loud, they are not unpleasant. In the pine forests of Okinawa a somewhat larger and related bulbul, *Microscelis amaurotis,* made itself known to the American troops by its noisy calls and inquisitive jaylike habits. Like other bulbuls it builds a simple, cuplike nest in a tree or bush and lays a few spotted eggs.

FAIRY BLUEBIRDS AND LEAFBIRDS—ZOO FAVORITES

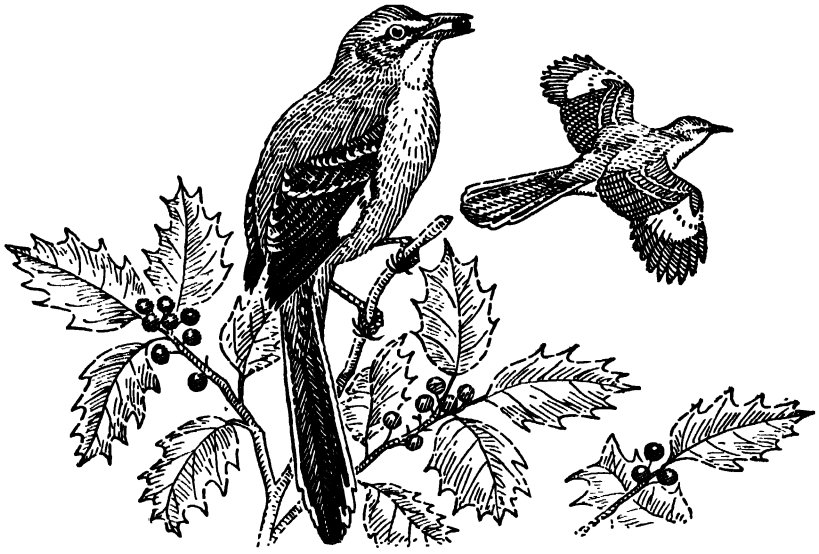
Many of the sixteen species of this small family are favorites in zoos and aviaries. Related to the bulbuls to some extent, they are usually brighter in color and differ in other ways as well. They are at home in the tropical parts of Asia, the Philippines, and the East Indies.

The Fairy Bluebirds, *Irena,* are brilliant birds, glistening blue with black marks. The Leafbirds, *Chloropsis,* are also brightly colored, but green and yellow or orange are their main colors. The members of the Irenidae family, the fairy bluebirds as well as the leafbirds, live on fruit and, to a lesser extent, insects. Their nests, which they place in a tree, are open, cuplike structures.

MOCKINGBIRDS, THRASHERS, AND CATBIRDS

"Listen to the mockingbird!" the song goes, and you will find the advice well worth taking. Unmatched as a vocalist, the mockingbird has a haunting song that it pours out as it perches on the ridgepole of a cabin in the southland. With a rich repertoire of songs of its

own, the mockingbird also mimics almost every other bird and frog found in its neighborhood. With equal ease it negotiates the sparrow's chirping, the swallow's twittering, the crow's cawing, the whippoorwill's strident call, and even the scream of the hawk.



"LISTEN TO THE MOCKINGBIRD!"

The mockingbird is adept at imitating the whippoorwill, crow, hawk, and many other birds—so much so that we easily forget that it has a very beautiful song of its own. However, as far as looks are concerned, this superlative songster is anything but striking.

The Mockingbird, *Mimus polyglottos* ("many tongues"), is by far the most famous of this New World family, the Mimidae, which contains thirty species. Slender birds with long tails and short, rounded wings, they are partial to dense brush. There is nothing in the mockingbird's appearance to give you a hint of its superb song—it is merely a gray and white bird of robin size. Common throughout the South, it is the state bird of Florida, Mississippi, Tennessee, Arkansas, and Texas.

The Brown Thrasher, *Toxostoma rufum,* like all other members of this family, frequents dense brush; but when it is about to sing it mounts to the top of a tall bush or tree, and that is the best time for you to watch it. An excellent songster, it rarely mimics other birds. A distinctive feature of its song is the repetition of each phrase.

The brown thrasher, a long-tailed bird with reddish-brown and white plumage, is the only thrasher found in the eastern United States. Two or three other kinds make their home in the desert areas of southwestern North America. They have sandy-colored plumage—useful in such surroundings—and they dig for food in loose sand with their long, curved bills. As they dig, they often swing the head from side to side. Although the brown thrasher has a very short singing season, we have found the Crissal Thrasher, *Toxostoma dorsale*, still singing its somewhat similar song as late as November in Sonora, Mexico. These long-legged birds spend much time on the ground. They are shy and make off rapidly in the thorny desert brush whenever they are disturbed.

The Catbird, *Dumetella carolinensis*, one of the commonest birds of the United States, has a petulant, scolding note very similar to the *meow* of a cat. The catbird's song, if we may call it that, is a squeaky, grating travesty of the songs of the mockingbird and thrasher. Yet the catbird is closely related to the thrashers and has similar habits. It has deep slaty gray plumage with a chestnut area under the tail. Its range is more northern than the mockingbird's.

Like other members of this family, the catbird builds a cup-shaped nest placed in dense bushes. Its eggs are unspotted greenish blue, while those of the mockingbird and of most thrashers are spotted.

WRENS—SOME ARE CAVE DWELLERS

Wrens are small, chunky, energetic birds with a rather long tail usually held straight above the back, giving them a pert air. Related to the thrashers and thrushes, wrens have wings that are short and rounded at the tips.

The Winter Wren, *Troglodytes troglodytes*, is the only Old World wren, and one of the smallest of the sixty-odd species of the family Troglodytidae. The term "troglodyte" (cave dweller) alludes to the liking of this wren for creeping about, almost like a mouse, in dark recesses beneath river banks or among the roots of overturned trees. As its common name tells us, the winter wren is hardier than the other members of the family, which are mostly confined to the warmer regions of America. It was through this partiality for more

northern latitudes that the winter wren was able to enter the Old World from America via Alaska and Siberia.

Like its cousins, this wren has a melodious, bubbling song. Its nest is a globular ball of moss, with an entrance hole on the side. It lays six or eight tiny speckled eggs. Like all other wrens, this bird feeds on insects and their eggs.

The House Wren, *Troglodytes aedon,* is as apt as not to change mates for each of the two or three broods raised during a season. At least that was the conclusion reached from a study of the "marriage relations" of the house wren, conducted in Ohio. It would seem that no lasting ties develop between mates, and if one of them is impelled by an urge to begin a nesting cycle before the other, a change of mates is likely to take place.

The house wren is a familiar bird in most parts of the United States. If you put up a small birdhouse in your backyard, you may have a "Jenny Wren" as a summer guest. The male utters his bubbling song incessantly—it has been counted as much as six thousand times in a single day. When a birdhouse is not available to a pair, they nest, like their ancestors, in a natural cavity in a stub. The nest, built of twigs, is surprisingly bulky. Wrens are rather intolerant of other small birds, and they are believed to puncture the eggs of other birds on occasion.

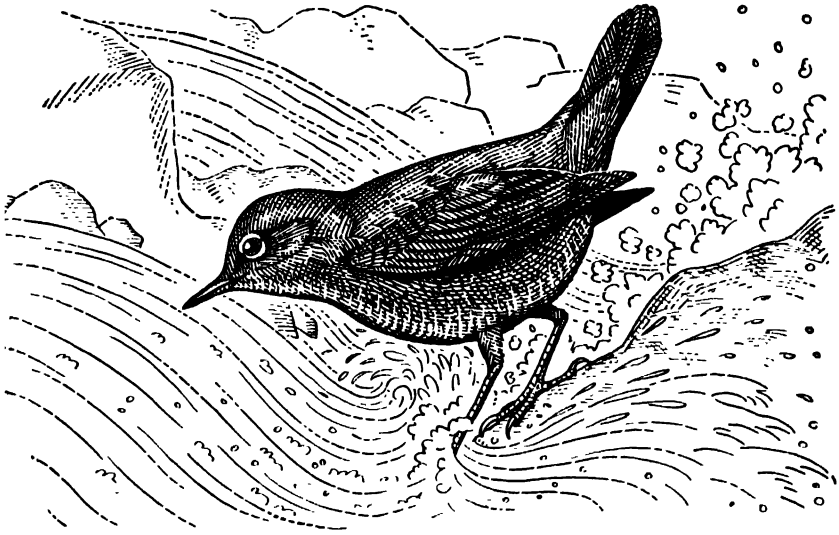
The Cactus Wren, *Heleodytes brunneicapillus* ("brown-cap"), dwells in the southwestern American deserts. About the size of a catbird, it is much larger than most of its cousins. Its plumage is a checkered pattern of browns, grays, and buffs. In appearance the cactus wren is not unlike a small thrasher, but its grating and churring call notes are distinctly wrenlike. The nest of the cactus wren is a large, globe-shaped mass of sticks lined with grass and placed in some cactus or spiny mesquite bush where it is safe from most enemies.

Some tropical wrens are so furtive that it is almost impossible to observe them. At such times we must content ourselves with listening to their vocal accomplishments. Occasionally we can hear a pair of wrens sing a duet, uttering alternate notes in perfect timing.

DIPPERS—THEY WALK UNDER WATER

Dippers or water ouzels appeal to our fancy chiefly because of their remarkable ability to walk under water. Not only are they capable

of doing this—they seem to take keen delight in it. They like to spend their time in and along the borders of ice-cold "white-water" mountain streams, and snowy waterfalls up to an altitude of 11,500 feet—sometimes even higher. Indeed, they spend their lives in a strange, intimate relationship with such streams, where they fly strongly from rock to rock, often breaking forth in a series of shrill flight notes as though thrilled by their closeness to the roaring waters.



A BIRD THAT WALKS UNDER WATER

The dipper delights in the presence of water, and walks under the surface in quest of small creatures to feed on. So dense is the plumage of this thrush-sized bird that it can withstand temperatures of 50 degrees below zero.

While afoot, usually on water-washed rocks, the dipper sings a bubbling, wrenlike song. When hunting, the bird flicks its tail restlessly and often bobs into the water head first, sometimes submerging completely for many seconds. With wings partly open, it walks along the bottom feeding on water beetles, caddis flies, dragonflies, and other water-dwelling insects. When the dipper swims on the surface, it paddles its feet alternately.

Dippers the world over—they comprise the family Cinclidae—are closely similar in structure and dress. All are the size of small thrushes, with stocky bodies, short tails, and thin straight bills. Predominantly grayish or brownish above, they sometimes have dark

under parts—as in our dipper, *Cinclus mexicanus.* In other dippers the under parts may be contrasted with buff or white on the chest and throat. As for their plumage, it is so dense and oily that dippers easily survive temperatures of 50° below zero in Alaska.

The dipper constructs its nest of grass and moss with a fine lining of leaves and rootlets. A domed affair with a narrow side-entrance, the nest is placed near water—on rocks, under bridges, or even on ledges behind waterfalls. The eggs are white. Dippers raise up to three broods a year, each of them from three to seven in number, often in the same nest.

WAGTAILS AND PIPITS—THEY SING AS THEY FLY

One of the members of this family has had the distinction of being starred in a full-length moving picture—probably the only songbird to be honored in this way. This is the Tawny Pipit, *Anthus campestris,* a European bird and now perhaps the most noted member of the family Motacillidae.

Wagtails and pipits are slender, graceful birds famous for their habit of singing in flight. The great majority of the forty-five species are restricted to the Old World. The pipits, *Anthus,* are more widespread than their cousins, and two types of pipits make their home in North America.

Like the larks, longspurs, and some other ground-running birds, wagtails and pipits have a very long hind claw; their legs are long and slender. Many species have a habit of constantly wagging the tail up and down. Though these birds feed almost universally on the ground, a few have learned to run along horizontal tree limbs.

Wagtails are attractively colored in black, white, and yellow. Pipits, on the other hand, have the streaked brownish plumage of typical grassland birds. The nest of these birds is an open cup, built of grass and rootlets, lined with hair and feathers, and placed on the ground. Four to six eggs are laid.

The Gray Wagtail, *Motacilla cinerea,* is a Eurasian bird usually found near water. In the Philippines we have watched it pacing nervously along the edges of swift mountain streams, feeding on water-dwelling insects. This predominantly grayish species is about eight inches long.

The Oriental Tree Pipit, *Anthus hodgsoni,* a bird of Asia and

Indo-Malaya, has moved its feeding niche from on or near the ground to the upper portions of forest trees. Near Baguio in the Philippines we saw it running like a squirrel along the horizontal limbs of pine trees. This species is olive brown, mottled with black above and pale buff below, with black spotting. Its length is about six inches.

AMERICAN PIPITS

The American Pipit, *Anthus spinoletta,* which nests on the arctic tundra and above treeline in the Rocky Mountains, may often be seen on open fields or along sandy shores throughout the United States when it is migrating. Despite this bird's dull olive-gray plumage, you can easily identify it by its high-pitched call note and restless habits.

The other American species is Sprague's Pipit, *Anthus spraguei,* discovered by Audubon on his expedition to the upper Missouri and called the "Missouri Skylark" because of its melodious song delivered from high in the air. This trait, you will recall, is one for which the lark is famous. The similarity in habits and appearance between larks and pipits is all the more remarkable since these birds are not related. On the wind-swept arid plains of Mexico we rarely saw Sprague's pipit until it jumped up from under foot with a sharp note of alarm and made off with rapid, erratic flight. This pipit has a habit of plummeting to earth so abruptly that only the most careful observation enabled us to mark where it landed.

OLD WORLD FLYCATCHERS

As you can tell from their name, these birds live in the Old World and they feed on insects. The family is a very large one, with 325 species—yet, not one of them is found in the Western Hemisphere! Among the most avid insect-chasers are a group called *Rhipidura* ("fantail"); they dwell in the Oriental and Australian regions. They are very tame birds, and one of them, the Australian Fantail, is an amusing creature on several counts. Its habit of constantly moving its tail has earned it the nickname of "Willie Wagtail." In its quest for flies, it even enters the doors or windows of buildings.

To aid them in engulfing their prey, flycatchers have broad, flat bills flanked by long bristles. Some flycatchers, however, pick insects

from foliage or twigs; these have rather heavy, slightly hooked bills. It has probably occurred to you that these birds, which make up the family Muscicapidae, may be related to the New World Flycatchers, which have similar tastes in food; interestingly enough, the relationship, such as it is, is not particularly close.

Though a few flycatchers are found in the temperate parts of Eurasia, these are exceptional; the family is overwhelmingly tropical in distribution. Among the most striking are the Paradise Flycatchers—beautiful birds with flowing tail feathers about a foot long. The Indian Paradise Flycatcher, *Terpsiphone paradisi*, has black under parts and a white back and tail. In Africa we find several related species which build a neat cuplike nest of moss and rootlets and lay from two to four spotted eggs.

As for the fantails, which we mentioned earlier, they are all very active in their pursuit of insects, seizing them with an audible snap of the bill. In the pine forests near the Philippine summer capital of Baguio we found a handsome Rufous and Blue Fantail, *Rhipidura cyaniceps*, one of the commonest and most attractive of the local birds. Other fantails have succeeded in colonizing the Pacific islands as far east as Guam and the Fijis. Fantails weave a neat cuplike nest and leave a dangling "tail" of loose fibers beneath it.

The Monarch Flycatchers (*Monarcha* and relatives) are even more prevalent in the Pacific—they have reached such remote islands as Tahiti. They are good-looking birds, with chestnut, white, and glossy black the main colors in their plumage.

Naturalists believe that the Hawaiian Elepaio, *Chasiempis sandwichensis*, belongs to the monarch flycatcher group. (Incidentally, the scientific name of this bird may strike you as queer unless you recall that the Hawaiian Islands used to be called the Sandwich Islands.) The elepaio is a very friendly and inquisitive bird—such a favorite, in fact, that the Hawaiian Audubon Society has named its journal *The Elepaio*.

Another group of Australian flycatchers has the curious name *Pachycephala* ("thickhead"), a reference to their rather heavy head and bill. Accomplished vocalists, they are also known as "whistlers." One species, *Pachycephala pectoralis*, has more geographical races or subspecies than any other bird—some eighty-odd are known! This clan is found throughout Australia, New Guinea, and most of the Pa-

cific islands. Members of the group of shrike-billed flycatchers, these whistlers pick insects directly from foliage.

THRUSHES—SWEET SINGERS

The Robin, *Turdus migratorius,* the most familiar of all native birds in most parts of the United States, is an outstanding member of the thrush family. Even in towns and cities you can often see this red-breasted thrush as it hops about on lawns in search of earthworms. It is interesting to watch a robin tugging and heaving to get the worm out of the ground. Some observers credit these birds with the ability to hear a worm stirring underground. The male robin looks very much like his mate, except that he is a little brighter below and darker on the head. As for the young, they are spotted with blackish marks on the breast when they are ready to leave the nest. We find such spotting in almost all young thrushes; it helps distinguish them from some of the related families, such as the Old World warblers and flycatchers.

The robin's nest is a sturdily built structure of mud and grass placed on the branch of a tree or even upon window sills or other ledges of buildings. Robins seem to take rather a casual attitude toward the problem of choosing a site for the nest; where it is not hidden or inaccessible, the young fall victim to cats and other enemies. Still, the species flourishes—apparently because it raises two or three broods a year. The color of the eggs is the well-known "robin's-egg blue."

The song of the robin is famous for its cheerful quality—a loud, clear carol that may suggest a military air to you. But let its nest or young be threatened and the robin protests with strident chirps, calling the attention of all and sundry to its plight. In addition to worms, insects are the robin's favorite food; however, it has an unfortunate partiality for fruit which sometimes makes it a nuisance in cherry orchards.

In the mountains of the West, the robin nests as far south as Mexico. Formerly it did not nest in most of the southern United States, but in recent years it has been showing a tendency to nest in the Southeast. While some robins are willing to brave the rigors of winter weather, the great majority migrate south. At that time of the

year they assemble each night in vast numbers to roost. Up to 1913, when they received protection, the birds were sometimes shot for food at such roosts.

OTHER INTERESTING THRUSHES

There are some three hundred kinds of thrushes, making up the family Turdidae, and many of them are native to America. Of these latter, the best loved is the Bluebird, *Sialia sialis.* Of purest sky-blue above and tinged with chestnut below, it has gentle habits and soft warbling notes that endear it to all countryfolk. Normally the bluebird places its nest in a hollow stub but it will nest in such sites as a dilapidated country mailbox. The starling, introduced from Europe, often drives bluebirds from their nesting burrows and sometimes kills them with a blow of its bill. If you provide a birdhouse for bluebirds, the entrance should be made small enough to keep starlings out.

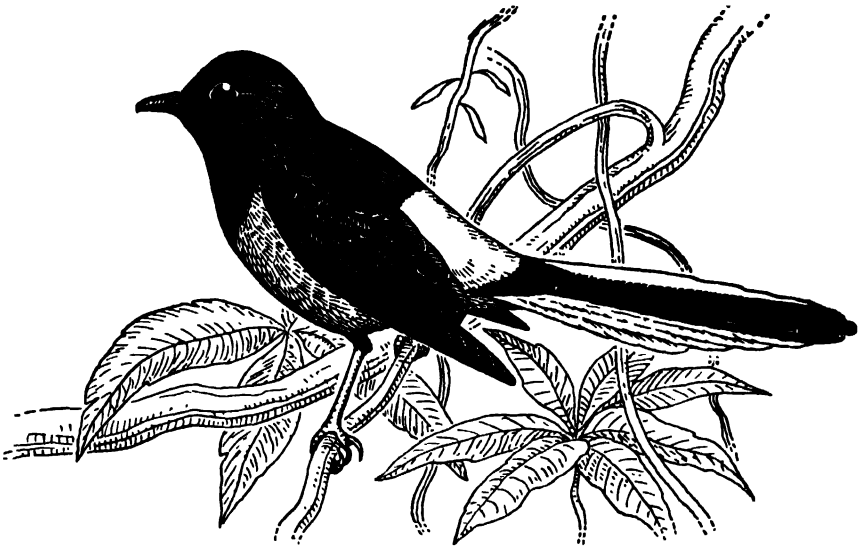
The Mountain Bluebird, *Sialia currucoides,* which dwells in the Rocky Mountain area, is uniformly blue throughout. A somewhat similar—though larger—related species, *Grandala coelicolor* ("heavenly color"), frequents the remote mountains of western China and Tibet.

Unlike the bluebirds, the American thrushes of the genus *Hylocichla* are birds of modest yet pleasing brown and white coloring. The group includes the Wood Thrush, the Hermit Thrush, the Veery, and the Olive-backed Thrush—all of them exceptional songsters. The clear, bell-like notes of the wood thrush, which you can often hear within the limits of suburban towns, are considered by some the finest song of any American bird. Quite different is the veery's song with its wild, vibrating cadence. The European Nightingale, *Luscinia,* is closely related to the American thrushes we have just mentioned, and like them it is a bird of rather somber plumage yet superb powers of song. As is well known, it sings mostly at night.

Still another melodious American thrush is the Townsend Solitaire, *Myadestes townsendi,* a bird of the Rocky Mountains region. Its pure notes are especially appealing in the wilderness where it dwells during the nesting season. Even near its home the solitaire is shy and retiring. We once found its nest on a rocky ledge above a beaver pond in the Medicine Bow Mountains of Wyoming. Though

the nest held half-grown young, the parents made no outcry when we visited it and they usually remained out of sight.

When the early American colonists named the native robin after the Old World Robin Redbreast, *Erithacus rubecula,* they made a mistake which has continued to flourish for centuries. True, robin redbreast is also a thrush, but it is much smaller than the American robin and its habits are quite different. Actually, the Old World Blackbird, *Turdus merula,* despite its quite different coloring, is a closer relative of the American robin.



A FAMOUS THRUSH OF INDIA

The thrush family is noted for beautiful singing and this is especially true of the shama thrush, which dwells in the streamside thickets and jungles of India. Its song is usually heard at dawn and again at the close of day.

Among the many characteristic thrushes of the Old World are the wheatears. One species, the Greenland Wheatear, *Oenanthe leucorrhoa,* barely enters North America at each of its northern corners, Greenland and Alaska. Many other wheatears live in the deserts of the Middle East and Africa. Most of them have conspicuous white rumps and black marks on the head and throat.

The Redstarts, *Phoenicurus,* are another group of Old World thrushes. One of them, the Black Redstart, though formerly very rare in the British Isles, has found the bombed-out ruins of blitzed

cities to its liking and now nests in some numbers amid those desolate surroundings.

BABBLING THRUSHES—NOISY BUT MELODIOUS

From a name like "babbler" you would conclude, rightly, that these birds are usually noisy. So they are—yet some of them are pleasing songsters. This Old World family is very large, with its 260 or so members. Most babblers live in underbrush or on the ground. They are generally medium or small size, but a few are as large as jays. As a rule their colors match the brush and undergrowth, though some of them have bright red patches in the wing, or other touches of color.

The most interesting members of this family (Timaliidae) include the laughing thrushes of the genus *Garrulax,* which occur in great variety in the Himalayas. One species, the Song-babbler, *Garrulax canorum,* has been brought to the Hawaiian Islands and is now well established there. We found it to be a fine songster with rich alto notes. In form and habits it reminds us of the American thrashers. Another introduced babbler now common in Hawaii is the so-called Pekin Nightingale, *Liothrix lutea.* It utters a *churring* alarm note as it swarms through the underbrush; the song is quite melodious.

Another variety, the parrot bill, creates problems. Naturalists used to place these birds with the titmice, but today the parrot bills are believed to be babblers. Actually, the parrot bills may be a link between the titmice and the babblers. Some parrot bills are partial to reed beds in swamps. This is true of the Bearded Titmouse, *Panurus,* the only babbler in the British Isles or, for that matter, in most of Europe. This bird's scientific name is interesting—like "the great God Pan" it is found among the reeds.

Another outlying parrot-bill babbler is the curious Wren Tit, *Chamaea fasciata.* Some naturalists believe that this California bird is the only American babbler, with relatives no nearer than faraway China. Like most members of the family, it builds a simple cuplike nest placed in low bushes. The eggs are pale blue and unspotted.

As for the family as a whole, babblers are related to thrushes but usually have stronger legs and shorter, more rounded wings. The young are not spotted. It is interesting to note that babblers stand

in much the same relation to Old World thrushes as do thrashers and mockingbirds in the New World.

KINGLETS, GNATCATCHERS, AND OLD WORLD WARBLERS

Among the oddities of this fascinatingly diverse family are the Tailorbird, which sews with the dexterity of a trained seamstress, the Canegrass Warbler, the tiny gnatcatchers and kinglets and the equally tiny but far more brilliantly colored Wren Warbler of Australia and New Guinea. Prominent among the almost four hundred species are the warblers found in Europe, and the common names of some of them will give you a good idea of their haunts and habits: Garden Warbler, Blackcap, Barred Warbler, Reed Warbler, Marsh Warbler, Sedge Warbler, Melodious Warbler, Willow Warbler, and Wood Warbler. Two that are named amusingly for their songs are the Grasshopper Warbler and the Chiffchaff.

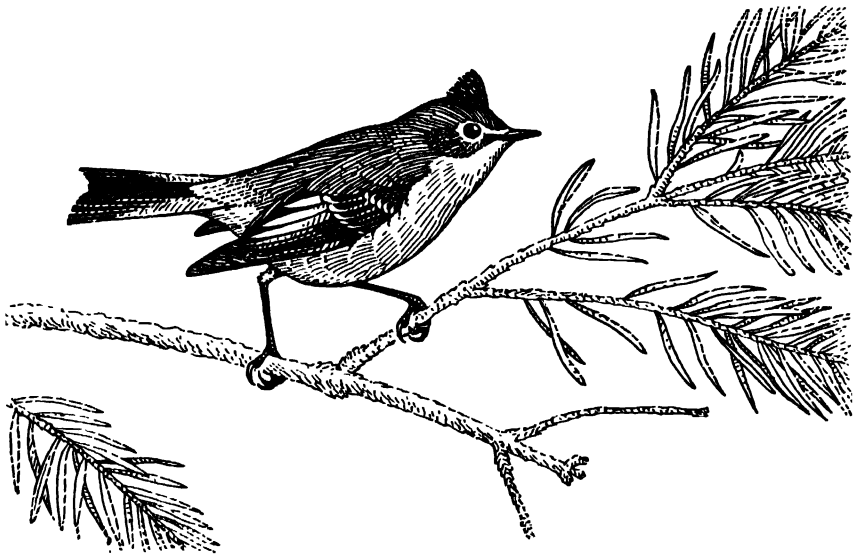
The Striated Canegrass Warbler, *Megalurus palustris,* a Philippine bird, is ten inches long and the largest member of this family (Sylviidae). This "giant" warbler lives in reed beds and in deep grass among bushes and thickets. It is essentially the color of dead grass, brownish with white striping and dull gray under parts. This warbler utters its beautiful song—a melodious whistle—as it flies excitedly upwards from its perch. The ball-shaped nest, fastened to tall grass stems over dry ground, has a side entrance.

The common Tailorbird of the Philippines, *Orthotomus atrogularis,* is a nervous little creature of the bamboo thickets and forest edge. It is famous for its habit of stitching the edges of several large leaves together with strands of grass and thus forming a pocket in which its nest is placed. This species of tailorbird, which has relatives in Africa and Indo-Malaya, has olive-colored upper parts with a reddish-brown crown and tail. The wings are greenish, the under parts whitish.

The Alaska Willow Warbler, *Phylloscopus borealis kennicotti,* is the only Old World warbler of its clan to reach the New World, and even so it winters in the Eastern Hemisphere. In its winter habitat we have found it in small flocks feeding quietly in the topmost leaves of the forest canopy on Luzon in the Philippines. A tiny green war-

bler, it is practically indistinguishable in the field from many related species.

The Golden-crowned Kinglet, *Regulus satrapa,* and the Ruby-crowned Kinglet, *Regulus calendula,* are both New World birds. They belong to the subfamily Regulinae, which has seven species in all and ranges as far north as there are trees. Both New World kinglets are tiny olive-green birds that flit nervously about in the middle and upper branches of orchard and woodland trees. Very tame, they have the distinctive habit of constantly flicking their wings. The ruby-



THE RUBY-CROWNED KINGLET—A NOTABLE SONGSTER

Though not so famous as the nightingale or the lark, the ruby-crowned kinglet is one of the outstanding songsters of the bird world. Despite its nervous mannerisms, this small bird is surprisingly tame. The crest is erected only when the kinglet is excited.

crowned kinglet is endowed with powers of song far out of proportion to its diminutive size; indeed, we may class it among our great songsters. Kinglets nest in the north, wintering in the United States and south to Mexico and Guatemala. They lay five to ten whitish eggs sprinkled with brown or purple; their nests, little baskets of moss lined with rootlets and feathers, are suspended above the ground in cone-bearing forests.

The Blue-gray Gnatcatcher, *Polioptila caerulea,* is one of a dozen

or so New World species that make up the subfamily Polioptilinae. A tiny bird with a long tail, it has a weak but elaborate song. Its nest, placed on the limb of a forest tree, is made of grass, beautifully decorated with lichens. Four or five whitish eggs, heavily marked with brown spots, are laid. Related gnatcatchers make their home in the thorny brush of the southwestern deserts. As they flit from bush to bush they utter grating, wrenlike notes.

Most members of the Sylviidae are small, rather inconspicuous denizens of forest cover—grass, bushes, or trees. All feed on insects. Though one of the most important Old World families, the Sylviidae are represented in America, as we have seen, only by a few kinglets and gnatcatchers. The Old World warblers are very closely related to the babblers and Old World flycatchers. We have also noted that the Old World warblers are excellent songsters. In this respect they differ from the unrelated wood warblers of America (Parulidae), which usually have weak songs. We can distinguish the Sylviidae from the Parulidae in several other ways—the former have fluffier, more hairlike plumage, they possess ten instead of nine primary feathers, and they are usually given to drab coloring.

CHICKADEES AND TITMICE

The Black-capped Chickadee, *Parus atricapillus,* is one of the best-loved American birds. Chickadees are very friendly and inquisitive little birds. With even slight encouragement they will come to your hand to secure sunflower seeds or peanuts, although they feed mostly on small insects and their eggs. These they can find even during the winter, so they do not migrate to any appreciable extent. Many people put out food (suet or sunflower seeds) for them in the wintertime. Even in bitter, snowy weather small flocks of them flit through the woods, as cheerful as ever. They assume all sorts of acrobatic poses in their search for food.

The chickadee is gray above and whitish below, and you can easily recognize it by its famous black cap and black throat. "Chickadee" is a good rendition of its call note. During the nesting season this bird utters a clear, pleasant two-syllabled whistle, sounding like "pee-wee." Beginners at bird study often assume this to be the note of the phoebe, which, as we know, is a flycatcher.

In the spring the sociable flocks of chickadees break up into pairs.

Each pair chooses a rotten stump in some secluded woodland and digs a hole in which the seven or eight spotted eggs are laid. They also roost in these holes on cold winter nights. We find a close relative of the black-capped chickadee in the Old World; it is known as the Willowtit. This is the bird that inspired the well-known song in *The Mikado.*

OTHER NOTEWORTHY TITMICE AND THEIR KIN

The Tufted Titmouse, *Parus bicolor,* is slightly larger than the chickadee and more plain colored. Uniformly gray, it has a reddish wash on the sides, and a jaunty, pointed crest. The tufted titmouse is of rather southern distribution, ranging north to New Jersey. A closely related species, the Gray Titmouse, lives in the West. The prettiest member of the chickadee and titmouse family (Paridae) is the Old World Blue Titmouse, *Parus caerulus.* It is a charming little bird, with pastel shades of blue and yellow predominating in its plumage.

In southwestern United States and Mexico we find the tiny Bush-tit, *Auriparus minimus* ("smallest"), a plain-colored bird that moves through the thorny desert brush in small flocks. An incessant chipping calls attention to their progress. These birds build a long baglike sack for their nest.

Another southwestern species is the Yellow-headed Verdin, *Auriparus flaviceps,* a grayish-green bird with a yellow head. The verdin lacks the confiding, pleasant habits of most of its cousins. Instead, it flits nervously about and scolds loudly as soon as anyone approaches its domain. Naturalists believe that the verdin is related to the Penduline Titmice, *Remiz,* an Old World group, which get their name from their habit of weaving penduline (hanging) nests. Some of the African species weave their nests so skillfully that the finished product resembles heavy felt. The spoutlike entrance to these nests is on the side and is sometimes protected by a soft overhanging projection which the bird pushes aside each time it enters or leaves!

NUTHATCHES—OCCASIONALLY NUTCRACKERS

The White-breasted Nuthatch, *Sitta carolinensis,* a common bird in most parts of the United States, feeds mostly on small insects and their

eggs and larvae. However, it also opens nuts by the ingenious method of jamming them into a crevice and then cracking ("hatcheting") them with repeated blows of its strong, pointed beak. The name "nuthatch" refers to this habit.

You can immediately recognize the white-breasted nuthatch by certain distinctive traits. Gray above and white below, it patrols the trunks and limbs of trees in search of insects. This may remind you of the woodpeckers and creepers, but the nuthatch differs from these birds by using only its feet—not its tail—in clinging to the bark. This gives it far more freedom of action, and it can hop head first down tree trunks with ease. We have even seen the Philippine Coral-billed Nuthatch, *Sitta frontalis*, hanging from the bottom of a branch with one foot while it scratched itself with the other foot.

The white-breasted nuthatch selects a natural crevice in a tree and enlarges it as much as necessary to form a chamber for its eggs and young. Some of the Old World nuthatches plaster mud around the entrance to the nest cavity until just enough room remains for the birds to squeeze by. Thus squirrels and other enemies are foiled. The nuthatches of the Persian deserts build their nests entirely of mud; attached to a rock, these nests may weigh as much as fifty pounds. Nuthatches make up the family Sittidae.

OTHER COLORFUL NUTHATCHES

The Red-breasted Nuthatch, *Sitta canadensis*, a more northern bird than its white-breasted cousin, has a white-striped head, reddish flanks, and higher-pitched call notes. During the nesting season it prefers heavy evergreen forests, but while migrating it frequents orchards and parks. The only other American species are the little Pigmy Nuthatch, *Sitta pygmaea*, a western bird, and the Brown-headed Nuthatch of the Southeast. These sociable little nuthatches roam about the forests in little groups, incessantly uttering their harsh nasal calls; nuthatches do not sing.

The Tree-runners of Australia, *Neositta*, look like nuthatches and behave like them. However, the tree-runners differ in their nesting habits and may be unrelated to the nuthatches.

CREEPERS—THEY RARELY USE THEIR WINGS

The Brown Creeper, *Certhia familiaris,* is a far-ranging North American bird that typifies the true creepers. Its flight is weak and fluttering and is chiefly used to make short descents from the top of one tree to the base of another where it resumes its nervous, unending search for insects and their eggs and larvae which it gathers from crevices in bark. It sounds a soft lisping note as it spirals up the bark.

Many forms of this species make their home in the Northern Hemisphere—there are groups of creepers in the British Isles, Japan, and in North America, and all told they comprise the family Certhiidae. More slender and smaller than a sparrow, this creeper is mainly bright brown with ochraceous white streaks and dull white under parts. It has thin graduated tail feathers ending in woodpecker-like spines which help it in creeping up tree trunks. The bill is long, slender, and curved. The long sharp toes provide the creeper's feet with a firm grip as it climbs.

The brown creeper—the only true creeper in North America—has five relatives in Europe and Asia. However, naturalists include fifteen or so Old World birds in the family, although their relationship is not yet fully understood. All have the same general form and show similar feeding adaptations.

The brown creeper places its nest of bark, wool, moss, and twigs under a large, loose piece of bark. In late May it deposits five to eight white eggs, speckled and wreathed with reddish brown. Naturalists have found nesting creepers in the mountains as far south as North Carolina. The chief breeding range, however, is from the northern portions of the United States northward.

The Wall Creeper, *Tichodroma muraria,* which dwells in the Alpine regions of Eurasia, is a very beautiful bird. Seven inches long, it is the largest of the creepers. In its wings there are pretty patches of red, visible only when it is flying. When at rest, it appears dull gray with a black throat and chest. We are told that unlike other creepers, this bird has a melodious call. Feeding on spiders and insects, it lives in rocky areas, chiefly around cliffs, often reaching great altitudes in summer. It nests in rock cavities, constructing a cup of grass and moss where it lays three to four spotted eggs.

FLOWERPECKERS—THEY LIKE MISTLETOE

Flowerpeckers are very small birds, often brightly colored with red or yellow. Noted for their active, sprightly habits, they are fond of the sticky berries of the parasitic mistletoe and are guilty of spreading the seeds of this harmful plant. They also eat small insects, nectar, and fruit. The nest, usually a pear-shaped bag with a side entrance, is similar to nests of sunbirds, to which the flowerpeckers are related. The fifty or so species of flowerpeckers—they make up the family Dicaeidae—are best represented in the Orient, although several are found in New Guinea and Australia.

Perhaps the best-known flowerpecker is the Australian Mistletoe Bird, *Dicaeum hirundinaceum*. This tiny bird lives at the top of the tall eucalyptus trees, and its flight is very rapid and darting. Its nest is remarkably pretty—woven of soft cottony vegetable down and hanging from a branch as if the twigs had been pushed through it.

The curious little Australian Diamond Birds, *Pardalotus*, so called because their plumage is "spotted like the (leo)pard," are members of this family. Unlike other flowerpeckers, they hunt for insects in foliage and dig little tunnels in the ground in which to build their nests.

AUSTRALIAN HONEY EATERS

Hawaiian princes used to have their lovely feather capes made from the yellow and black feathers of a beautiful species of honey eater that is now extinct. The natives called it the "o-o" in imitation of its call.

Today the honey eaters, which compose the family Meliphagidae, are almost entirely confined to the Australian region. These birds have a long, tubular tongue for sucking nectar from flowers. The brushy tip of this tongue is sticky, enabling the honey eater to catch insects and spiders efficiently. Honey eaters are medium-sized or even large songbirds, usually marked with yellow and adorned with tufts of long yellow feathers or with wattles. We find these birds on many Polynesian islands.

The Tui or Parson Bird, *Prosthemadera,* one of the best known of New Zealand birds, is somewhat similar to the extinct species we mentioned earlier. Its dark metallic green plumage, set off by curling

white feathers on the throat, inspired its popular name, "parson bird." Flitting rapidly about the branches of the forest, pecking here and there at a stray insect or diving its bill into the recesses of a newly opened flower, it continually utters a shrill, sharp whistle.

WHITE-EYES—AVID EATERS OF NECTAR

Naturalists have a hard time telling the nearly eighty species of white-eyes apart. Most of these birds are greenish with a silvery-white eye-ring, and are exasperatingly similar in appearance. The few which lack the white eye-ring look like small green warblers, and they are even more perplexing to identify.

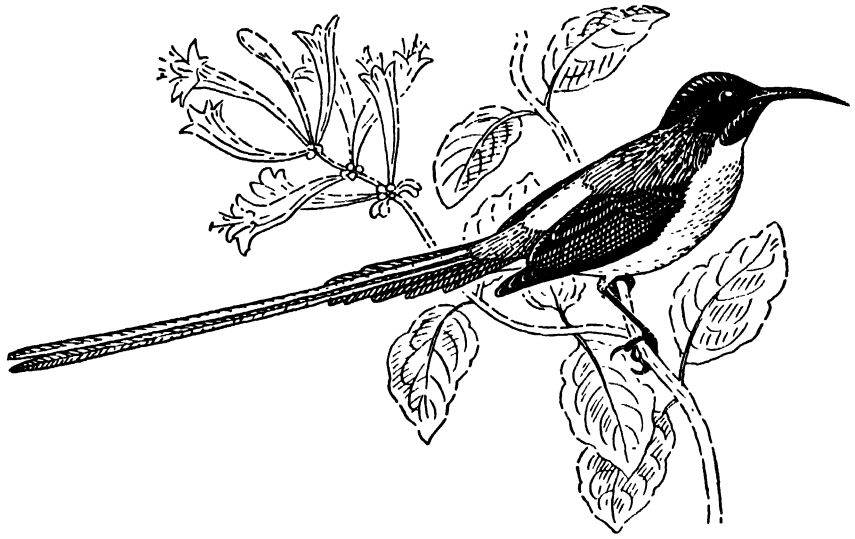
White-eyes are sociable, active, restless, vireo-like birds; they make up the family Zosteropidae. We find them in Africa, Madagascar, southern Asia (north to Japan), and the Australian region. Despite the resemblances to various birds that we have noted, they are thought to have their closest kinship with the Australian honey eaters.

The Japanese White-eye, *Zosterops palpebrosa japonica,* is a good songster and is often kept as a cage bird. When released in the Hawaiian Islands by some of the Japanese colonists, it spread like wildfire and is now far more common than any of the native Hawaiian birds. On an estate in the Philippines we saw a large flock of golden-headed white-eyes feeding avidly on nectar obtained from the blossoms of an ornamental tree. To aid them in such feeding, many white-eyes have a tubular tongue. These birds also eat berries and doubtless some insects. Their nest is a cup swung in a horizontal fork, like the nest of an American vireo. The eggs are usually blue and unspotted.

SUNBIRDS—HUMMINGBIRDS OF THE OLD WORLD

It is not illogical to call sunbirds the hummingbirds of the Old World, though the two groups are quite unrelated. Sunbirds fill the niche that hummingbirds occupy in the New World tropics and resemble them in brilliance of plumage and in feeding habits. On the other hand, they do not have the humming flight of their American counterparts, nor are they so small, ranging in size from four to eight inches. Males are often strikingly iridescent while the females and young are more drably colored.

Sunbirds have a long, slender, curved bill. The tongue is tubular and extensible, a feature we have noted in hummingbirds and others that feed on nectar. When feeding, sunbirds hover before a flower like the hummingbird, or else they perch beside the blossom and probe it for honey, small insects, and spiders.



THE BEAUTIFUL LONG-TAILED SUNBIRD

Many members of the sunbird clan are strikingly handsome, but the long-tailed sunbird is outstanding, with its glossy green head, shiny purple lower back and tail, and rich yellow under parts. This sunbird has very long middle tail feathers.

We find the species of sunbirds, making up the family Nectariniidae, in the warmer parts of the Old World. Their favorite haunts are the middle and upper forest portions up to altitudes of five thousand feet. Some species frequent bushes in native gardens. These birds have a weak, sometimes melodious song, and they also utter a variety of chipping notes. The sunbird's typical nest is a pear-shaped affair of grass, moss, rootlets, and spider webbing. Beautifully camouflaged, this hanging nest is often remarkable for a tubular, spoutlike side entrance which sometimes resembles a tiny porch. The sunbird lays two or three whitish or pastel-tinted eggs, sprinkled with many colors.

The Malachite Sunbird of Africa, *Nectarinia famosa,* notable for its brilliance and its greatly elongated central tail feathers, is one of the most beautiful species. This is particularly true of the male,

dressed in glistening iridescent green. The bird has a total length of about eleven inches, including the three inches of feathers that extend from the tail. The bill is long, slender, and curved.

Another spectacular member of the tribe is the Scarlet-chested Sunbird, *Chalcomitra senegalensis,* also of Africa. Six inches long, it is iridescent green on the forehead and sides of the face, with a scarlet lower throat and chest. The sprightly habits and colorful appearance of this bird and many of its cousins of the Old World tropics have won for them the appropriate name of "sunbirds."

The Gray-breasted Spider-hunter, *Arachnothera affinis,* which lives in southeast Africa, is an unusual bird—it builds an open, cup-like nest in tall plants near native habitation. These spider-hunters are about six inches long, with a long, heavy, black bill. The male is yellowish olive above, grayish brown below.

VIREOS—INCESSANT SINGERS AND SKILLFUL BUILDERS

Perhaps you have heard of the "Brain-fever" Bird, a small brush cuckoo of the Orient that sings incessantly at siesta time from a single perch, and is reputed to have driven men mad. We have no comparable tales about the vireos, but it is true that most of them have rather loud voices, and several species seem to sing almost continuously. The Red-eyed Vireo, for one, utters a monotonous chant from dawn to dark.

These warbler-like birds of woodland and brush are less nervous and jerky in their movements than warblers and their coloring is quieter and of more protective value. This exclusively American family (Vireonidae) contains forty-one or so species. For the most part they are small, olive or grayish-green birds which sometimes travel in the company of warblers. Feeding almost solely on insects and their larvae, they sometimes add berries to their menu in the fall. Methodically they scan bark surfaces, small twigs, and leaf surfaces for food, and you may be sure that very little escapes their attention.

Vireos take great pains in building their nests. They all weave beautiful little hanging basket-like nests which are attached to horizontal forks. The nest locations may be as low as three feet from the ground, or as high as ninety feet. The usual nest material is grass, plant fibers, lichens, and spider webs; often the rim is decorated with

fine moss. Vireos lay four or five white eggs finely sprinkled with brown and black spots.

Vireos have a uniformity of habits that is remarkable considering their wide variety of favored environments all the way from sea level to an altitude of nine thousand feet. Those that breed in the cooler portions of the Northern Hemisphere migrate into the tropics in winter. The most familiar and widespread member of the family is the Red-eyed Vireo, *Vireo olivaceus*. You can find it wherever there are trees in any number, be they in parks, along roads, or in deep woodlands. Olive green or white below, it has a slate-gray cap bordered on either side with black. A white line runs over the eye, which is red in the adult, brown in the young birds.

A few tropical vireos, such as the so-called Pepper-Shrike, *Cyclarhis*, have an unusually heavy bill. In fact, there is some doubt whether they are vireos at all.

BOBOLINKS, BLACKBIRDS, MEADOWLARKS, ORIOLES, AND THEIR RELATIVES

The Bobolink, *Dolichonyx oryzivorus,* is one of the most popular birds over much of the eastern and central United States. Many consider it the best singer of all American songbirds. The ecstatic bird treats us to a bubbling, happy melody as he flies slowly with quivering wings above the hayfield where his mate is incubating her four to six eggs. The bobolink's nest is a flimsy grass cup, placed in a depression in the grass.

The male is a handsome bird, black below, black, white, and yellow above. His modestly colored mate is streaked with buff and gray, closely matching the grassy fields where bobolinks dwell. With the coming of fall the male, too, molts into this protective plumage. The bobolink is a great migrant, traveling all the way to the Argentine pampas to spend the winter. In former days, when much rice was grown in the Carolina lowlands, flocks of migrating bobolinks appeared in the fall and ate their fill. In fact, the scientific name of this bird means "rice eater." The bobolink is perhaps the most outstanding bird of the family Icteridae, which also includes blackbirds, meadowlarks, orioles and other familiar birds.

The Eastern Meadowlark, *Sturnella magna,* **and the Western Meadowlark,** *Sturnella neglecta,* are so similar that you would find it difficult

to tell them apart. One point of difference is that the western kind has a more melodious song. The male and female are nearly alike in color. Streaked above for camouflage in the grass, they have



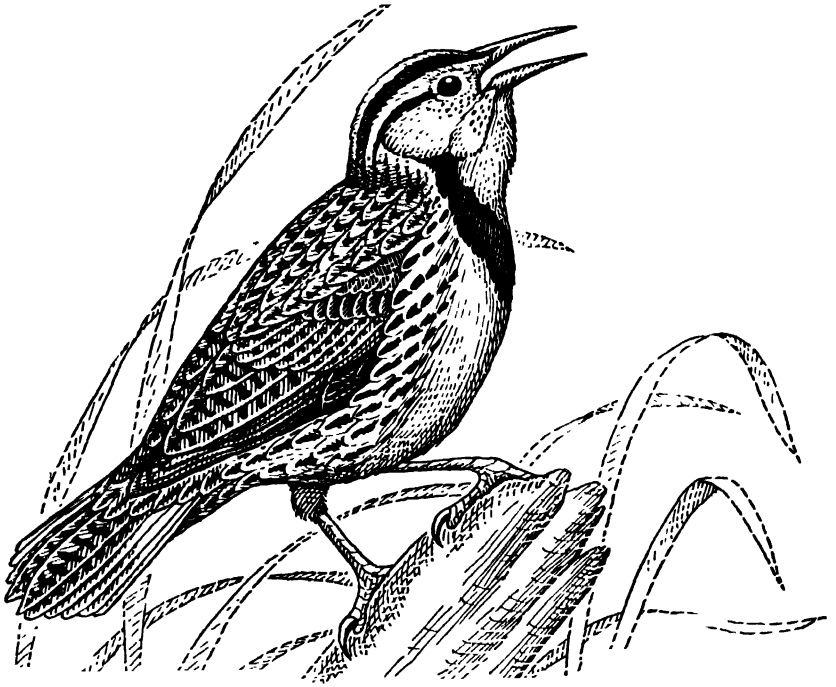
THE BOBOLINK—ONE OF AMERICA'S MOST POPULAR BIRDS

The bobolink is one of the best-loved American birds. It is an ecstatic singer, and it is also one of the great migrating birds, wintering regularly on the Argentine pampas. It is sometimes called the ricebird.

a bright-yellow breast and black bib. The outer feathers of the short, broad tail are white. The birds are quite noticeable as they take flight from a grassy field or twitch their tails nervously as they perch on a fence post. Meadowlarks are as chunky as quail, and have a somewhat similar flight—rapid bursts of wingbeats, followed by short glides. For this reason meadowlarks were formerly shot as game birds.

The Red-winged Blackbird, *Agelaius phoeniceus,* is probably one of the ten most abundant birds in the United States. The male is a handsome bird, glistening black with brilliant scarlet shoulder

patches or epaulets. In the spring he flaps slowly through the air to display these marks to his mate and to all others who may watch and admire. The song is a loud, mellow *kong-ka-ree*. In the fall, this blackbird and other species gather in large flocks and are sometimes destructive to grain.



THE MEADOWLARK RELIES ON PROTECTIVE COLORATION

The meadowlark builds its nest on the ground and spends much of its time in grassy fields, where its streaked upper parts blend with its surroundings. This bird is a great destroyer of crop-damaging insects in summer; in winter it consumes weed seeds in large quantities. In flight, the white outer tail feathers are conspicuous.

The red-wing prefers marshes but has learned to nest even in dry hayfields, as two noted American naturalists, Theodore Roosevelt and John Burroughs, were the first to point out. The nest of the red-wing is a carefully woven cup suspended, as a rule, among reeds in a marsh. The eggs, like those of many of its relatives, are bluish white, marked with irregular blackish scrawls.

The Crow Blackbird or Grackle, *Quiscalus quiscula,* also a common bird in the United States, has a voice so squeaky that it has

been likened to the creaking of a rusty gate. Almost as large as a blue jay, this bird has entirely black plumage, that of the male being highly iridescent, with bronzy, greenish, or purplish reflections in the sun. A less attractive bird than many of its cousins, the grackle sometimes kills the young of other birds by a blow of its heavy bill, and may also be destructive to grain.

In the southern swamps we find a related though larger species, the Boat-tailed Grackle, *Cassidix mexicanus.* The males are black, the females brownish, and the former are much larger. As we so often note about birds where this difference in size prevails, the male is polygamous. In Mexico the boat-tailed grackle is less limited to marshes than in the southern United States, and each little village or ranch has its noisy flock.

COWBIRDS—THE ONLY PARASITIC AMERICAN BIRDS

Very similar to blackbirds in appearance, cowbirds are nevertheless unique among American birds for their parasitic habits. For that matter, it is stretching a point to include the cowbird among the songsters, for the courtship call of the male is a very creaky whistle produced only at the expense of disproportionate effort and bodily contortion as he sits on a dead limb. The male Eastern Cowbird, *Molothrus ater,* is shiny black with a brown head; the female is dull grayish.

Stealthily the female cowbird seeks out the nests of smaller birds—song sparrows, ovenbirds, yellow warblers, vireos, and many others. Then, early in the morning she slips onto the nest and lays one of her own eggs. The morning before doing this, she usually removes one of the eggs of her victim by puncturing it with her bill and carrying it off. As a rule she lays only one egg in a nest, seeking another nest for the next egg.

Usually the victimized bird does not object to the strange egg and incubates it with her own. The young cowbird is almost always bigger than its nest mates and with its greedy appetite monopolizes the food brought by the parents. The likely upshot is that the true young of the foster parents starve, and the parents are left with the single young cowbird, often twice their own size! Even so, the young cowbird continues to beg shamelessly for food for some time after leaving the nest.

The cowbird is a common species, with the result that in some areas as many as half the nests of song sparrows, ovenbirds, and others of its favored victims suffer from its invasion of their homes. Thus you can see that the cowbird is responsible for the destruction of many young songbirds; but perhaps many of these would in any case represent surplus population. Dr. Herbert Friedmann made an interesting study of certain South American cowbirds in which parasitism is less perfected or entirely absent. By studying the behavior of these birds, Dr. Friedmann was able to show how the parasitic habit has evolved.

The Baltimore Oriole, *Icterus galbula,* is a lovely orange and black bird. It gets its name from the fact that its colors are the same as those of the House of Baltimore, the patrons of the colony of Maryland. Aside from its handsome appearance, the Baltimore oriole is also notable for its deep, carefully woven nest which is attached to the thin end twigs of a tree. The bird prefers the drooping branches of the American elm above all others. Grass is the normal weaving material but horsehair and string are sometimes used. Once in a while we find a dead oriole hanging near its nest with a loop of string or horsehair around its neck—a victim of its own industry.

Though orioles are the most numerous members of this family in the American tropics, the Baltimore oriole is the only species that is common in the northern United States. Less brightly colored than her mate, the female still has enough orange hue in her plumage to be recognizable. The song of the Baltimore oriole is a series of loud, clear whistles, pleasant though not particularly melodious.

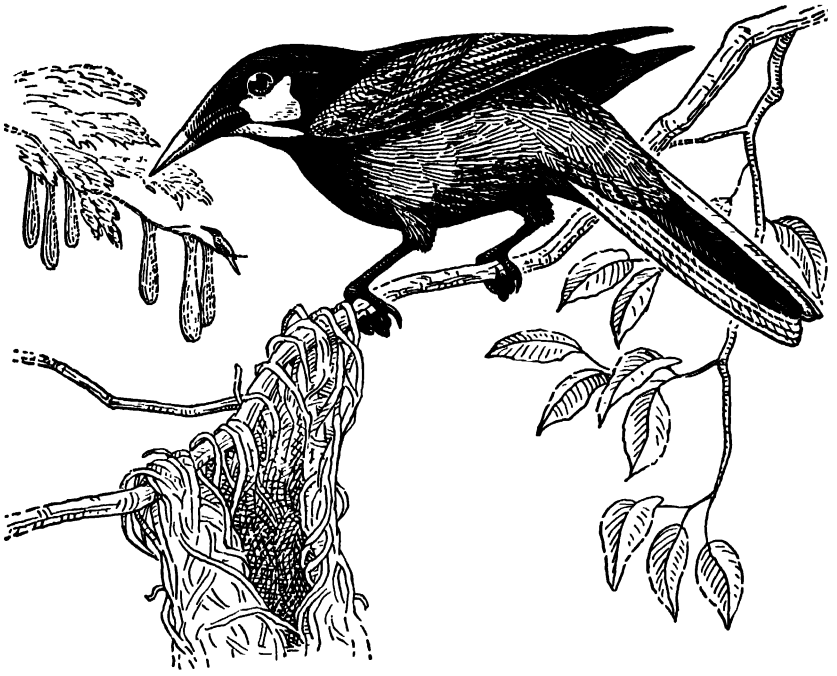
We find other orioles in the southern and western regions of the United States. Almost all of them weave artistic nests which are sometimes sewed into or suspended between large leaves. One attractive lemon-yellow and black species, Scott's Oriole, *Icterus parisorum,* is partial to the yuccas of the rocky hillsides of Arizona and Mexico.

OROPENDOLAS AND THEIR HUGE NESTS

Oropendolas—the name is Spanish—are tropical relatives of the orioles. They build hanging nests which are sometimes as much as three feet long. As a rule the nests are swung from some lofty jungle tree.

Usually oropendolas nest in colonies. The males are larger than

the females and, like the male cowbird, they make an acrobatic ritual out of uttering their gurgling courtship notes. Meanwhile the hard-working females weave the long swinging nests and raise the young. Some oropendolas are as large as a crow. They may be yellow or orange and black, like their close relatives the orioles, but some of the largest species have a greenish hue.



A BIRD THAT BUILDS LARGE SWINGING NESTS

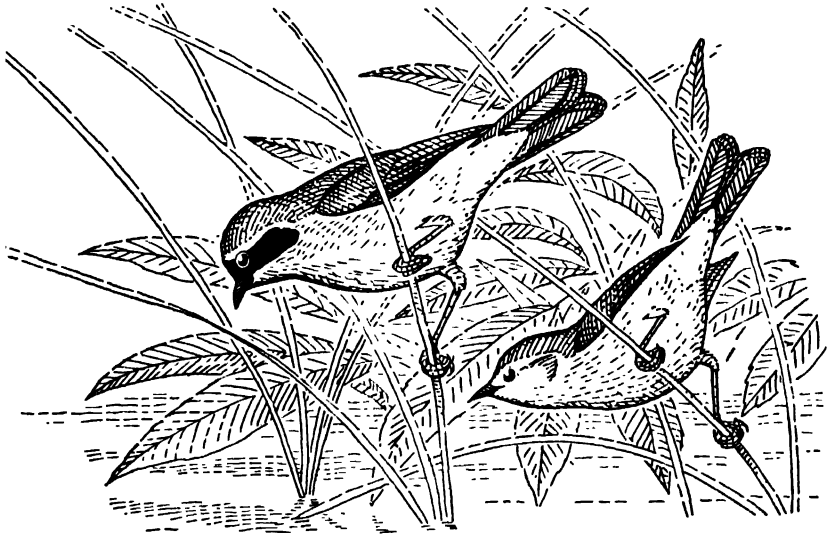
The oropendola, a tropical cousin of the orioles, is famous for its huge hanging nest, which is sometimes as much as three feet long. All the credit for weaving these remarkable structures belongs to the female; her mate remains aloof from the work.

NEW WORLD WARBLERS

New World warblers are small birds—smaller than a sparrow—and most of them are brightly colored. During their migrations you can see as many as twenty or more different kinds of warblers in a single morning in the northeastern United States. This variety makes them a favorite of bird students. Many of the warblers you see on these migrations have nested in Canada. On misty nights they sometimes

lose their bearings and large numbers are killed when they strike such tall obstructions as the Empire State Building in New York. Naturalists know of some 110 species of the family, the Parulidae, which is found throughout North and South America.

The Yellow Warbler, *Dendroica aestiva,* is the best-known species. Entirely yellow, it is lightly streaked with dusky or reddish markings. It arrives in the spring about the time the apple trees are in bloom and quickly announces its presence by its loud song. Most warblers, by the way, have rather lisping, high-pitched songs. Though they are poor music, the songs are a great help when you try to identify the birds. People sometimes mistake yellow warblers for goldfinches ("wild canaries"). However, if you study both birds, you will see that the yellow warbler lacks the black and yellow plumage pattern and the heavy bill of the goldfinch.



A WOOD WARBLER THAT DOES NOT LIVE IN THE WOODS

The yellow-throat, found throughout North America, lives in grass and weeds near streams. The black-masked male repeatedly utters his loud song, which sounds like "witchety, witchety, witchety." This bird builds its nest on or near the ground in a clump of grass.

The yellow warbler builds a neat cuplike nest of plant down and rust-colored fern fibers in which it lays four olive-spotted eggs. The parasitic cowbird, as we have seen, often lays one of its eggs in the

nest of the yellow warbler. Sometimes the victimized bird may react resourcefully by building a new bottom in its nest to cover up the alien egg and start again with its own egg laying. Like most members of this family, the yellow warbler feeds almost entirely on insects.

Among the relatives of the yellow warbler there are several that deserve mention. One of these is the Redstart, *Setophaga ruticilla,* a beautiful warbler with orange and black plumage. When pursuing a flying insect it has a tumbling butterfly-like flight that gives it the appearance of a streak of flame in the forest gloom. That is why the Cubans, who know this bird only as a winter visitor, call it the *candelita* ("little candle").

The Yellow-throat, *Geothlypis trichas,* favors tall grass and low bushes in marshes. Male and female are yellow, but the male has black masklike areas on the sides of the head. The yellow-throat's song is a loud "wichety" repeated several times.

GROUND WARBLERS

The ground warblers are well represented by the Ovenbird, *Seiurus aurocapillus* ("gold cap"). This bird should not be confused with the tropical Ovenbirds (Furnariidae), which we discussed earlier. The ovenbird of the warbler family has a brown back and white under parts spotted with brownish black. There is a golden area on the crown, but you can rarely see it. The ovenbird has yellow legs and, like the other ground warblers, it walks rather than hops. Its nest, roofed over like an oven, is made of grass and leaf stems on the forest floor. The ovenbird has a very loud song, resembling the word "teacher" repeated over and over with increasing emphasis. At twilight the ovenbird flutters above the lower trees and offers a sweet flight song.

The Louisiana Water Thrush, *Seiurus motacilla,* is, despite its deceptive common name, a cousin of the ovenbird. Partial to deep rocky glens or ravines, this water thrush builds its nest in a little depression in a stream bank. The Northern Water Thrush, *Seiurus noveboracensis,* has a wider range. During its migrations we may find it along the edges of streams or ponds. Like many other birds of similar habits—even such totally unrelated ones as the spotted

sandpiper or "tip-up"—the common water thrush is given to incessantly teetering up and down.

HAWAIIAN HONEY CREEPERS—VERSATILE BIRDS

When the celebrated explorer Captain James Cook discovered the Hawaiian Islands in 1768, he found the native princes wearing red, yellow, and orange robes made of the feathers of birds. These colorful cloaks were assembled from the feathers of the Hawaiian honey creepers, a family found only on these islands.

Among biologists, the Hawaiian honey creepers have long been famous as an example of "adaptive radiation" or "divergent evolution." To put it briefly, the structure of these birds has changed, depending on their ways of getting food. Thus, some of them have long, curved bills for sucking nectar from flowers; some are heavy-billed seed-eaters; still others are modified in many ways for feeding on insects. Since very few songbirds ever reached the Hawaiian Islands, this family (the Drepaniidae) was free to diversify and utilize the many sources of food available on these tropical islands. But living in isolation has its seamy side as well. About half of the twenty-two species of Hawaiian honey creepers are now extinct—they proved all too susceptible to diseases brought by birds introduced by man on the islands.

HONEY CREEPERS—THEY COMPETE WITH HUMMINGBIRDS

Honey creepers are birds with curved bills and long, tubular tongues adapted for feeding on the nectar and tiny insects found in flowers. Perhaps because they must compete with the hummingbirds, we find that the American honey creepers are much fewer in number of species—only thirty-five or so, making up the family Coerebidae—than their Old World counterparts, the sunbirds and Australian honey eaters.

Like many birds that feed on nectar and frequent the outer, sunnier portions of jungle trees, honey creepers are often brightly colored. The Blue Honey Creeper, *Cyanerpes cyaneus,* has black wings, tail, and shoulders; the rest of the body is a bright, glistening blue. The common Bananaquit, *Coereba flaveola,* a bird of the West Indies

and South America, is grayish above and yellow below, with prominent white lines over the eyes.

Most honey creepers build a domed nest with a side entrance. This nest is more of a home than most bird nests, for the honey creeper sometimes roosts in it, aside from using it for its eggs.

TANAGERS—COLORFUL BIRDS

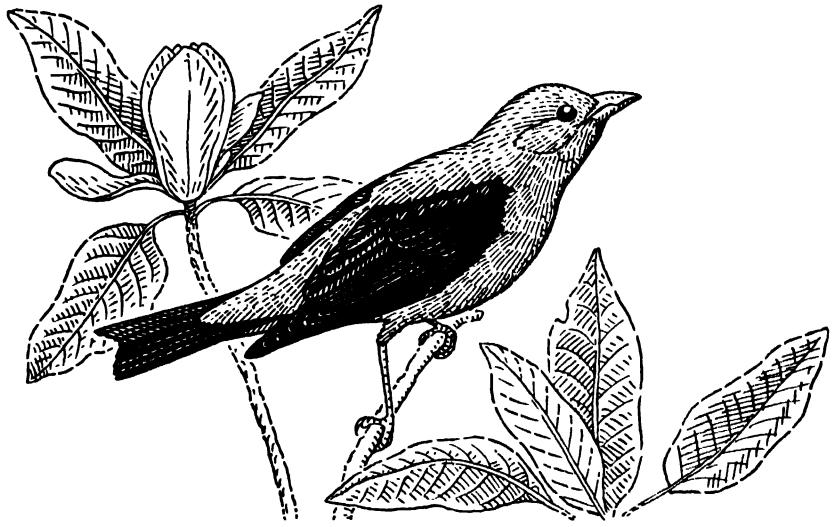
With its brilliant scarlet body and black flight plumes, the Scarlet Tanager, *Piranga olivacea,* is a typical member of the colorful family Thraupidae. As with many other kinds of tanagers, there is quite a difference in coloring between the sexes. The male is vividly dressed, the female is somber in appearance, green being a frequent color.

Closely akin to the finches, tanagers are usually thrush-sized, though a few reach the proportions of a starling or jay. Most tanagers have weak voices, but some species—the scarlet tanager is one of them, with its robin-like song—have pleasant songs. Tanagers frequently congregate in large mixed parties to feed—chiefly on insects and fruit which they gather in the forest. For the most part they live in trees; a few, shy and retiring, live on or near the ground in forests where they scratch for food like large sparrows or towhees. Contrast this with such species as the Bishop Tanager, *Thraupis episcopus,* of South America, which spend their noisy group existence close to man. Frequently we encounter the second type in city parks and about suburban homes.

While a few tanagers make ball-like domed nests, the typical tanager nest is a shallow structure of twigs lined with fibers and leaves, placed four to thirty feet above the ground in saplings. Two to four bluish or greenish-white eggs are laid. The great majority of the nearly two hundred species of tanagers dwell in the forests of the American tropics, with some reaching Canada and Chile. Four tanagers breed in the United States but return to warmer climes in winter.

Aside from the scarlet tanager, the only other species we find in the eastern United States is the Summer Tanager, *Piranga rubra;* the male is a beautiful rosy-red bird. The Western Tanager, *Piranga ludoviciana,* which substitutes for the scarlet tanager in the west, is bright yellow with black wings and tail and much scarlet on the neck

and head. One of the most vividly colored of the tribe is the tropical Paradise Tanager, *Tanagra chilensis*. Its velvety-black upper parts are contrasted with glistening apple green on the head, scarlet on the lower back, yellow on the rump, glossy opal blue on the under parts, and purple on the throat, neck, and bend of the wing.



A BRILLIANT BIRD OF NORTH AMERICA

The scarlet tanager, with its vivid scarlet body and black wings and tail, is one of the most brilliant birds of North America. The female, generally green, is not nearly so spectacular as her colorful mate. Interestingly enough, the male discards his striking plumage after the mating season, assuming a green garb very similar to the female's. Caterpillars and other slow insects are a favorite food of the scarlet tanager.

Some South American tanagers are quite extraordinary, as, for example, the Violaceous Euphonia, *Tanagra violacea*. No bigger than a tiny finch, this bird has purplish-blue upper parts and orange under parts. Some of these little euphonia tanagers live on the sticky covering of the berries of the parasitic mistletoe. The euphonia tanager is radically modified in order to consume this fare—instead of the stomach and gizzard found in other birds, it has a straight tube to permit ready passage of the seeds.

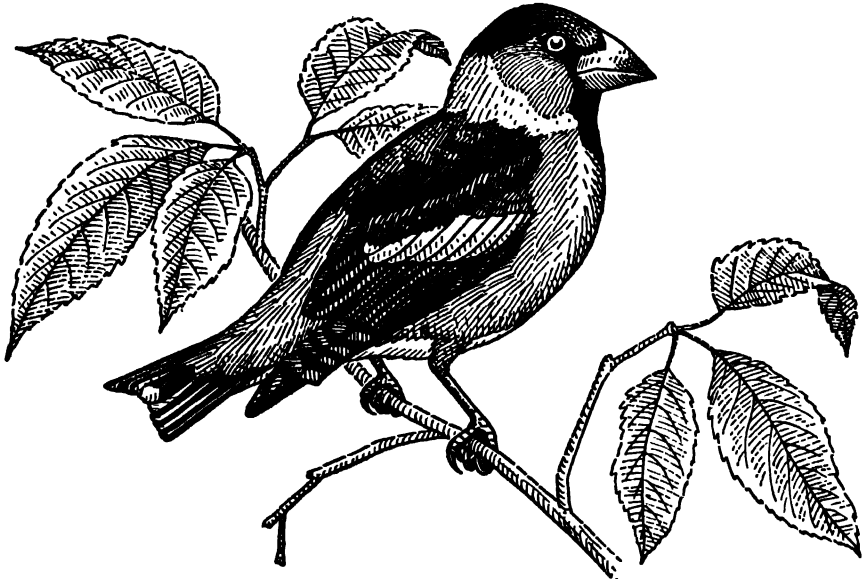
SWALLOW-TANAGERS

This South American bird, which looks like a cotinga, is apparently related to the tanagers. However, naturalists have placed the swallow-

tanager in a separate family (Tersinidae), partly because its skull structure has some unusual features, partly because it differs from the true tanagers in nesting in a burrow or hollow tree. The male swallow-tanager is greenish, tinged with beautiful opalescent blue and marked with wavy black lines. The female is more greenish.

PLUSH-CAPPED FINCHES

The Plush-capped Finch, *Catamblyrhynchus diadema,* is a curious little bird closely related to the tanagers and finches. It differs from them in having a crown capped with hair or spinelike plumes of a feltlike texture. There is only one species in this family (Catam blyrhynchidae) ranging from Venezuela to Bolivia in mountain forests where it is found in mixed flocks. The plush-capped finch has a black hind crown and maroon under parts. So far as we know, no naturalists have ever found the nest or eggs of this bird.



A BILL THAT CRACKS CHERRY PITS

A handsome study in pinkish brown, black, and chestnut is the hawfinch, a robustly built European member of the finch family. This bird, like its American cousin the evening grosbeak, has a huge bill. While it can crack cherry pits with ease, the hawfinch also consumes softer foods, such as green peas.

FINCHES, BUNTINGS, GROSBEAKS, AND RELATED BIRDS

With its 425 or so species, the finches and their numerous cousins make up the largest of all bird families. What is even more interesting is that the great Darwin's epoch-making work on evolution was inspired by his observations of a group of finches. This was how it happened: As a young man, Darwin took an assignment as naturalist on the famous voyage of H.M.S. *Beagle*. One of the most important stops made by the expedition was at the desolate, lava- and cactus-covered Galápagos Islands, lying about six hundred miles off the



THE GOLDFINCH OR "WILD CANARY"

The goldfinch, a cousin of the tame canary, is famed for its lovely call, *perchickoree, perchickoree* is what it sounds like. This bird's menu consists largely of dry plant fruits and seeds. The less brilliantly colored female *(left)* feeds her four to six babies with seeds which she has predigested for them.

coast of Ecuador. Here the young scientist came across a clan of finches called Geospizas or ground finches.

Every island in the group has a number of species of these unimpressive black or grayish birds. Often the species differ in little except the size of the bill. In trying to understand this variation, Darwin was led to speculate on evolution and the origin of species. That is why these birds are sometimes called "Darwin's finches."

Since finches are so diverse and dwell in all parts of the world, they still offer naturalists many problems. Generally speaking, finches —they make up the family Fringillidae—are small or medium-sized songbirds; very few are as large as the American robin. Their color patterns are endlessly varied; some are protectively colored, others are bright red or yellow. Many finches—the domestic canary, for example—are beautiful songsters.

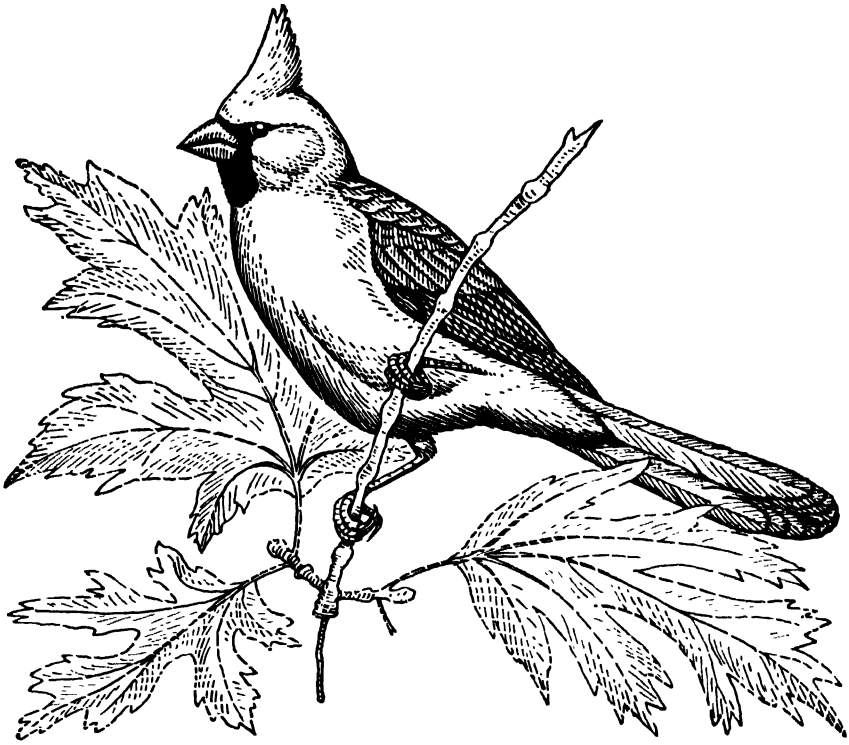
The Goldfinch, *Spinus tristis* ("sad"), is a handsome black and yellow bird that makes its home in North America. It nests rather tardily, from late June to August, building its nest largely of thistledown. The male has a lovely flight song. The call-note of the goldfinch is tinged with melancholy, hence its scientific name. In flight the goldfinch undulates up and down in the air, as though riding a roller coaster. Though it resembles a canary, the latter was derived from an Old World species.

The Common Crossbill, *Loxia curvirostra,* and **the White-winged Crossbill,** *Loxia leucoptera,* are both deep wine red, but the latter bird has white wing bars. In both birds we find that the sharp tips of the jaws cross and overlap. This is an adaptation for opening the cones of evergreens to secure the little seeds beneath the scales. While doing this, crossbills hold the cones in their feet, parrot-wise, and twist off the scales rapidly and efficiently with their unique bill.

The Song Sparrow, *Melospiza melodia,* is perhaps the best known of the numerous North American sparrows or buntings, thanks to the extensive studies Mrs. Margaret M. Nice has made of these birds. She has found that each pair has a territory in which the nest is located. The male's song tells other male song sparrows that he is in possession of a nesting territory and will brook no intrusion. The song also attracts a mate to his territory. We encounter such "territorialism" with many other birds. It is probably an adaptation to

prevent overcrowding, thus ensuring an ample food supply for the young.

The Cardinal, *Richmondena cardinalis*, belongs to a group of finches best represented in South America. The handsomely crested male is bright red, including even the bill; the female is much duller in color. Though commonest in the southern United States, the car-



LOVED FOR ITS BRIGHT COLOR AND CHEERY WHISTLE

The cardinal is named for its striking red color, which extends to its bill and distinctive crest. The bird builds its nest in a small tree or a thicket, and here it lays its three or four eggs. Feeding mainly on seeds and insects, the cardinal does considerably more good than harm. In bad winters, it often relies on bird feeding stations, to pull through.

dinal is seen locally as far as New York. It does not migrate, and a severe winter in the northern part of its range plays havoc with it.

The Evening Grosbeak, *Hesperiphona vespertina*, judging from its common and scientific names, ought to be active in the evening.

However, field observation does not bear this out to any appreciable extent. A large yellowish finch with black and white wings, it has a huge whitish bill—at least that part of its common name is accurate. It was formerly very rare in the Northeast but now occurs there more commonly. In the West it breeds south in the mountains to Arizona, but in the East we see it chiefly in wintertime.

The Rose-breasted Grosbeak, *Pheucticus ludovicianus,* is a handsome bird of almost robin size. One of the gems of the family, the male is black and white, with a beautiful rose-colored throat and breast. The female is discreetly attired in gray, brown, and white. The song of the rose-breasted grosbeak, similar to the robin's but more melodious, is uttered from the shady crown of a maple or other large tree. This grosbeak constructs a rather flimsy, cuplike nest made of rootlets, in which it lays three or four spotted eggs. In the western states we find a closely related but less striking bird, the Black-headed Grosbeak, *Pheucticus melanocephalus.*

WEAVERBIRDS—MASTER BUILDERS

Weaverbirds have a heavy bill which they use to crush seeds. At first glance this beak appears unsuitable for nest building. The fact is, though, that weaver birds, as you can gather from their name, weave expertly constructed hanging nests. One group actually makes a nest with a spoutlike entrance in both the front and back. These sociable birds usually nest in colonies. Some of them are very beautiful and are favorites with cage-bird fanciers. The weaverbirds comprise the family Ploceidae. Most of the 260 species of this exclusively Old World family make their home in the tropics.

Although, as we have just seen, most weaverbirds have a well-deserved reputation for first-rate nest building, a few species belonging to the genus *Viduao,* are the exception that "proves" the rule. They have a lazy habit of laying their eggs in the nests of other weaverbirds and leaving it to them to hatch out the eggs and rear the young.

The House Sparrow or English Sparrow, *Passer domesticus,* is the most famous member of the weaverbird family. This is unfortunate, for this noisy, quarrelsome pest is a far from typical weaverbird. Its nest

is an untidy affair, usually placed in a crevice of a building but sometimes among the branches of a tree.

House sparrows are very aggressive and bullying birds—often driving away martins, bluebirds and other desirable birds that favor similar places for their nest. The sparrow lays four to six spotted eggs, and brood follows brood during the warmer months of the year. Even a mild spell in winter is enough to start the males at their



MORE TAIL THAN BIRD

The large weaverbird family includes some of the ablest nest-builders. However, the paradise whydah (a *male is shown above*) is a notable exception. The female, who is plainly colored and lacks the long tail of her mate, lays her eggs in other whydah birds' nests, such as the one pictured. Paradise whydahs are popular cage birds.

noisy courtship antics, hopping about with wings drooping and tail widely spread as they chirp with all their might. Sometimes the hen sparrow appears annoyed at this vain performance, chasing the male away or even seizing him by the bill.

The house sparrow was unwisely introduced into New York about

1850; we now find it throughout the United States and in much of Canada and Mexico. Its native home is in Europe and Asia. This sparrow's association with horses is well known, and in recent years these birds have become less abundant now that automobiles and tractors have so largely replaced horses. When in good plumage, the male sparrow with his black bib and chestnut marks is rather attractive. Our city sparrows soon become so begrimed with dirt and soot that we can no longer make out their true appearance.

The Sociable Weaver, *Philetaerus socius*, is a relative of the house sparrow. Its fabulous building activities are confined to the arid plains of southern Africa, where the traveler sometimes sees a huge mass of straw and grass about ten feet high and six or eight feet in diameter, built among the thorny branches of an acacia tree. This is the "apartment house" nest of the sociable weaver. These birds assemble in a colony of thirty pairs—or even more—and pool their efforts in building this huge structure; each pair has an individual nesting chamber.

WAXBILLS AND THEIR RELATIVES

The waxbills often have exquisite colors. The Lady Gould's Finch, for example, is lilac and pink with a pointed tail; it looks like a miniature pheasant! We find some waxbills in Africa, but they have their greatest development in the Australian region. These birds belong to the subfamily Estrildinae.

The Parrot-bills, *Erythrura*, are red, blue, and green, the exact pattern varying from species to species. This is the only widespread group of weavers in the Polynesian islands—it occurs as far east as Fiji. The Ricebird, *Padda oryzivora* ("rice eater"), a gray and black species with white cheeks, is a favorite cage bird in the Philippines. Native vendors often trudge through the streets of Manila offering a pair of ricebirds in a tiny bamboo cage.

OTHER WEAVERBIRDS

There are many typical weaverbirds in the genus *Ploceus*. Best represented in Africa, they are also found in Asia. Nesting in large colonies, they hang their flasklike nests from the branches of trees or from papyrus or other tall grass. The male does most of the weaving,

and the female is content to add the nest lining. Most of these birds have considerable yellow in their plumage, often with a black throat or other black marks on the head. The females are more dully colored than their mates.

STARLINGS—ATTRACTIVE BUT AGGRESSIVE

The scientific name *vulgaris,* in the modern rather than classical meaning of the word, fits the starling very well. Though this bird can utter pleasant ringing whistles, it is more apt to draw attention to itself by harsh, unpleasant, sputtering scolding—especially when an intruder approaches its nest. This nest, by the way, is an untidy mass of straw placed in a hole in a tree, a birdhouse, or in cornices of buildings.

An attractive bird with its glossy, iridescent black plumage, the starling is unfortunately much too aggressive. In the United States the villain of the piece is the introduced Common Starling, *Sturnus vulgaris,* the only starling of western Europe. Once domiciled in the United States, the common starling thrived all too well, and has now reached the Pacific coast. Very pugnacious towards native birds, such as the flicker and the bluebird, it often kills them in their nesting holes with a blow of its sharp bill and then pre-empts their nests. Nor does the starling endear itself to the farmer by its occasionally destructive feeding habits; particularly annoying is its fondness for small fruits.

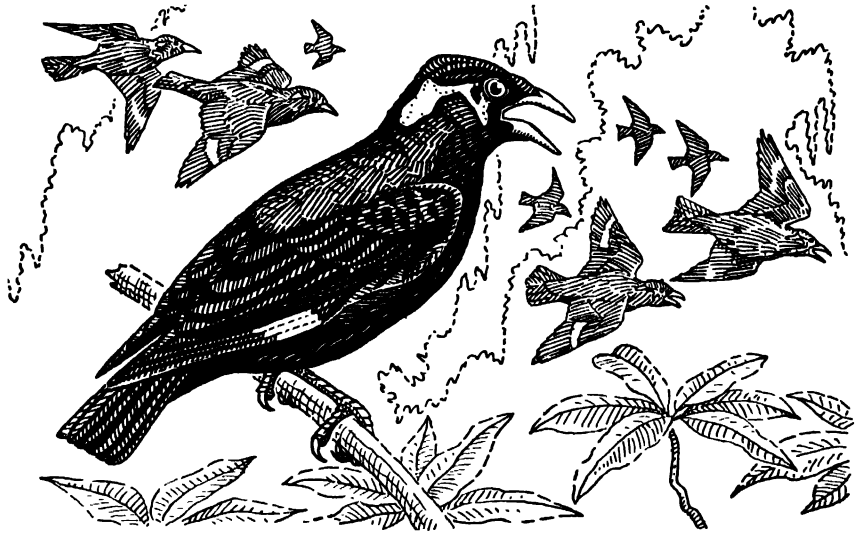
Of the hundred or so species that make up the starling tribe (family Sturnidae), all but a few dwell exclusively in the Old World tropics. Starlings are more or less migratory, especially in the Old World, but vast hordes of them winter in the northern cities of the United States. Each night they throng to favored roosts on public buildings or on the superstructure of bridges. If the neighboring area is illuminated to any extent by electric lights, the cries of the birds go on all night. The starling is in fact the prime example of the folly of introducing a foreign animal into a new country without carefully pondering the likely results.

In the tropics, the Common Mynah, *Acridotheres tristis,* of India, takes the place of the common starling. Like that nuisance it has been foolishly introduced into many other localities from South Africa to Hawaii. During the pairing or territorial squabbles of this

mynah, two or more birds often become embroiled in a bitter battle on the ground. At such times they are so engrossed in their squabbling that an alert cat may dash in and snatch one of them away.

The mynah is a typical starling: noisy, aggressive, and with slovenly nesting habits. Usually it nests in hollows like other starlings, though occasionally it builds domed nests in trees. In Hawaii the crown of a Royal Palm tree often shelters its nest.

Several kinds of starlings make interesting pets. Best known for this purpose is the Talking Mynah, *Gracula religiosa,* a native of the In-



A STARLING THAT TALKS

The talking mynah, a large starling of India, talks as well as a parrot or crow and makes an amusing pet. A handsome bird, the talking mynah has shiny black plumage relieved by white wing patches.

dian region. As you can gather from its name, it learns to speak as well as a parrot or crow. Two or even three times the size of a common starling, this bird has glossy black plumage with white patches in the wings. As is the case with many other starlings, its head is partly devoid of feathers and is ornamented with skin lappets or wattles.

The African glossy starlings are rather primitive members of the family. Some of them, like the Violet-backed Starling, *Cinnyricinclus leucogaster,* and the Long-tailed Spreo, *Spreo regius,* are very bril-

liant. Though much plainer in appearance, the African Oxbirds, *Buphagus,* lead a very curious existence. These specialized starlings have the bill modified for shearing ticks from the backs of rhinos, buffaloes, and other large mammals, and feed on little else but these ticks. On the island of Celebes in the East Indies we find a species which is superficially similar though unrelated to these tick-eaters. The Celebes bird uses its strong bill to dig out nesting chambers in dead trees —behavior that reminds us of some mynahs that dig nesting burrows in river banks.

The Rosy Pastor, *Sturnus roseus,* a more colorful relative of the common starling, nests north of India and migrates to that country to spend the winter. Every now and then there are mass movements of these birds into Europe, as far west as Hungary or even Switzerland. Making no effort to return, these birds attempt to nest in their new surroundings.

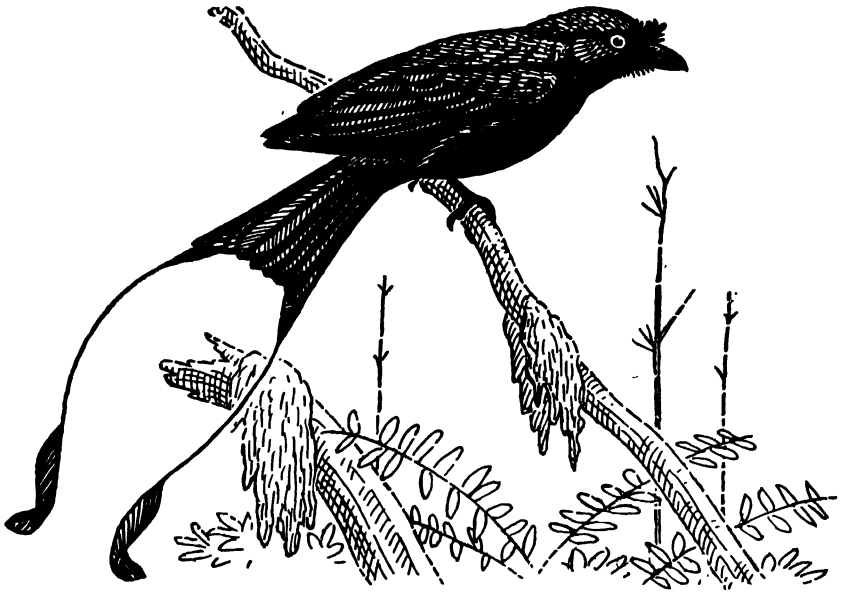
The only starlings to reach Australia and the Polynesian islands belong to the genus *Aplonis.* These plain, black birds are noteworthy because a few species nest in colonies and build long swinging nests similar to the ones made by the weaver-finches—a group to which the starlings may be related.

DRONGOS

Drongos are interesting birds. They all have a strongly hooked bill wreathed with highly developed bristles around the gape of the mouth which help them to scoop up their flying prey—insects. Drongos have a habit of sitting quietly for long periods in middle portions of deep forest. They sally out from selected perches in quest of winged insects—a trait that reminds us of large flycatchers. Often drongos accompany troops of monkeys, probably to secure insects disturbed into flight by the noisy animals. Like the American kingbird, the drongo puts up a spirited defense of its territory, even to the point of attacking hawks and crows. That is why drongos are known as "king crows" in India.

In appearance, drongos remind us of fork-tailed grackles or slender blackbirds. They are basically glossy black with bluish-green reflections. Male and female are similar in color and size. As a rule the voice of the drongo is soft and melodious, but sometimes it produces surprising sounds—as when it mimics crows or other birds. The

thirty-odd species of drongos—they make up the family Dicruridae —range from Africa, through Indo-Malaya to Australia. Nearly all make their home in tropical environs, though a few are found at altitudes up to five thousand feet in the subtropics.



THE DRONGO—A BIRD OF VARYING MOODS

The drongo is a trim-looking tropical bird which deftly catches insects on the wing. Its pugnacity towards hawks has given it the name of "king crow" in India. Shown here is the racket-tailed drongo. This bird is noted for its great skill as a mimic.

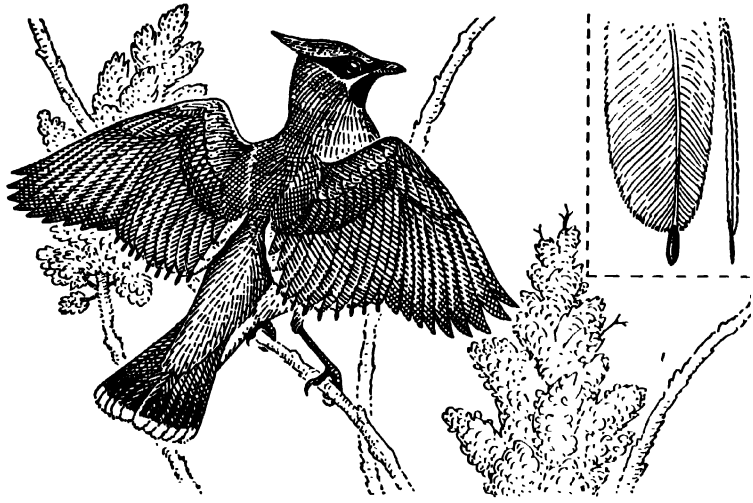
The typical drongo nest is a cup formed of grass, hair, or lichens, woven securely into a low tree-crotch in deep forest. Drongos lay three or four whitish or buff eggs with gray blotches.

WAXWINGS AND THEIR KIN

The family name of these birds, Bombycillidae, means "little silky ones," and refers to the soft, silky texture of their plumage. Waxwings are songless, uttering only reedy, lisping notes. They feed on fruit. Sometimes a row of them will pass a cherry or other small fruit from one bird to another until one of them finally swallows it.

There are three species of waxwings—the Japanese Waxwing, the

Cedar Waxwing of North America, and the Bohemian Waxwing. The Bohemian variety, despite its name, lives in the colder regions of both America and Eurasia. The waxwing has a modest but pleasing color scheme—soft browns set off by yellow-tipped tail feathers and bright red waxlike appendages on the wing feathers. The head is handsomely crested. The nest of the waxwing is a simple, open cup. This bird lays three to five mottled gray and brown eggs.



THE WAXWING—NOTED FOR ITS SILKY PLUMAGE

Though not much of a singer, the waxwing is an attractive bird, with pleasantly subdued colors, remarkably silky plumage, and a striking crest. Waxwings are mostly fruit-eaters, and a group of them will sometimes pass a cherry from bird to bird until the tidbit is finally disposed of. Two views of a wax-tipped feather are shown in the detail.

The waxwing will eat insects as well as fruit. The cedar waxwing has a great appetite for cankerworms, and a single flock of waxwings may consume close to three thousand worms in a day—or so runs a recent estimate. In this way the birds make up for the damage they do to fruits.

Related to the waxwings are the Silky Flycatchers, with half a dozen species ranging from southwestern United States to Panama. The best known is the Mexican "Flycatcher" or Phainopepla, a handsome black and white bird of the southwestern deserts. In the

winter it lives mostly on mistletoe berries. The Palm Chat, *Dulus*, which dwells on the island of Hispaniola in the West Indies, is another relative of the waxwings. Several pairs cooperate in building a large nest in which each pair has a separate nesting chamber.

WOOD SWALLOWS—SWALLOWS IN NAME ONLY

Alone among the vast array of perching birds, wood swallows have the peculiar powder downs found in herons and in some other birds. These powder downs consist of patches of continuously growing short whitish feathers which, in wood swallows, spring from the breast, thighs, and lower back. The tips of these plumes break up into a kind of talcum-like powder which helps keep the plumage in shape.

The wood swallow has long wings and a strong bill. It is chiefly notable for its graceful, floating flight which involves soaring and gliding, interspersed with short, swallow-like wingbeats. Naturalists know of ten species of these peculiar birds. The wood swallows—they comprise the family Artamidae—have no near relatives and no affinities with true swallows.

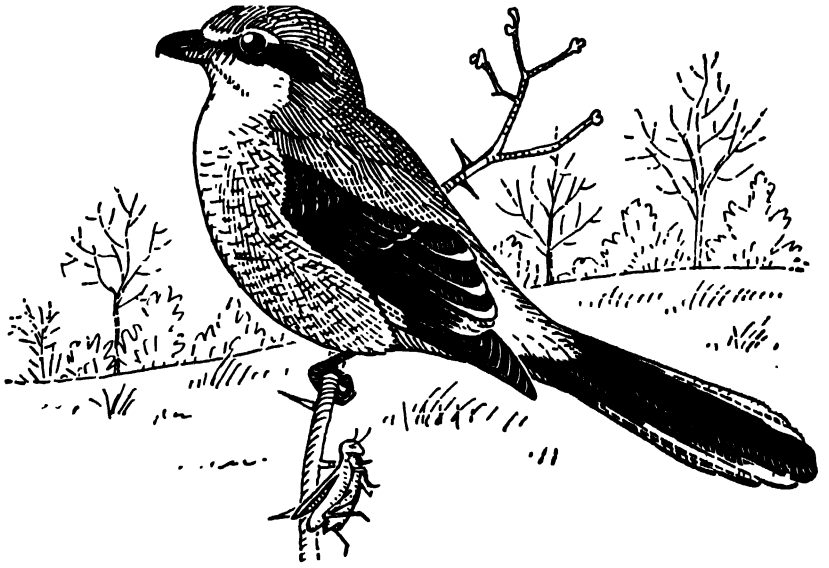
Usually found in open flocks by day and in tight clusters by night, wood swallows live in and about the crowns of tall trees growing in grasslands. As a rule they establish themselves near water and forage out from high limbs in search of flying insects. They may soar about for some time before returning to perch.

The wood swallows dwell in the Philippines, New Guinea, and Australia. Grayish black above and white below, they have long, pointed wings and bluish, waxy bills. Shortly before dusk a colony reassembles at favorite perches. Here they squeeze together for the night, back to back and side to side in tight knots. In Papua we found such tight-knit groups on slender limbs of eucalyptus trees in the lowlands. In the Philippines we discovered them in living and dead trees. If a colony is disturbed at dusk, the members explode outward in all directions; after dark it is difficult to flush them. At such times the knot of birds, when revealed by a flashlight beam, reminded us of a crumpled bath towel.

Male and female wood swallows are similar in size and color. We are told that they cooperate in incubating and taking care of the nestlings. Often a group of them will place several nests—open cups of grass and weeds—in a small area.

SHRIKES, OR BUTCHERBIRDS

If you have ever seen a shrike, you may have noticed that there is something paradoxical in its appearance—its bill is the bill of a bird of prey, yet its feet lack the powerful grasping talons that we expect in such a bird. The bill with its sharp, strong hook, reminds you of a hawk or owl, and not without reason; the shrike has adopted the carnivorous habits of those birds and, following their example, it feeds upon mice, small birds, and large insects. In the winter, the shrike is a relentless enemy of sparrows and chickadees.



THE SHRIKE—STRANGE BIRD OF PREY

There is no mistaking the meaning of the shrike's strong, sharp, hooked bill. Yet this creature lacks the talons we associate with a bird of prey. The shrike solves the problem of holding its victims by impaling them on pointed objects—thorns, for example.

But how, you may wonder, does the shrike come to grips with its prey if its feet are more or less like the feet of a songbird? The answer to this question explains why the shrike is called the "butcherbird." The shrike pursues its victim through thickets until the hunted creature becomes exhausted or confused. Thereupon the shrike, making use of the powerful bill, impales its prey upon a thorn or a barb in a wire fence, so that it becomes easy to dismember the victim.

When food is plentiful, shrikes may kill more mice than they can eat, and the surplus is left impaled on thorns. Shrikes build a substantial open nest and lay four or five mottled grayish eggs. Just as you would expect, they are bold and aggressive when it comes to defending their nest.

The shrikes are an Old World family (Laniidae). Only two of the seventy-odd species reach North America, and one of these, the Northern Shrike, *Lanius excubitor,* dwells in the Old World also. About the size of a robin, it is pale grayish with darker wavy markings on the breast and with black facial patches.

The Migrant or Loggerhead Shrike, *Lanius ludovicianus,* is commonest in the southern United States. Somewhat smaller than its northern cousin, it feeds extensively on insects as well as mice. We find many related shrikes in Eurasia and Africa. The bush shrikes of Africa, unlike the others, are often beautiful, brightly colored birds. They do not share the predatory habits of the other shrikes, and may be unrelated to them.

VANGAS—AT HOME IN MADAGASCAR

Only on the island of Madagascar do we find the dozen or so species of vangas, or vanga-shrikes, as they are sometimes called. As a rule they have rather heavy, hooked beaks resembling those of shrikes; yet it is doubtful if they are really close relatives of the shrikes. The bill varies in size and shape from species to species—a feature we can observe in many island birds. Thus, the Sicklebill, *Falculea,* has a long, curved bill; the Helmet Bird, *Euryceros,* has a very high, arched bill and was formerly placed in a separate family.

Most vangas are brown and black. Among the exceptions, the Blue Vanga is bright blue above and white below; the sicklebill, like the Hook-billed Vanga, is black above and white below. This hook-billed vanga, by the way, comes closer to the shrikes than does any other member of the vanga family (Vangidae).

Vangas move through the forest in mixed flocks that include birds of other families. They feed chiefly on insects, but the jay-sized sicklebill seems to favor small lizards. Vangas have a repertoire of loud, rather unmusical calls and whistles. The vanga uses leaf stems and grass for its open, cup-shaped nest, and lays two or three spotted eggs.

AUSTRALIAN BUTCHERBIRDS AND BELL MAGPIES

Like the shrikes or butcherbirds of other parts of the world, the Australian Butcherbird, *Cracticus,* kills mice, large insects, and even small birds, and impales them upon thorns while tearing them apart with its strong, hooked beak. These birds have a very large head, and a correspondingly large bill. Some are black and white, others entirely black; in size they approximate the familiar blue jay. The family has a dozen or so species, all of them making their home in the Australian region.

The Australian "Magpies," *Gymnorhina,* build a substantial nest of sticks and grass. They usually place this structure in a tree, but occasionally they locate the nest among the wires on a telegraph pole, where it has been known to cause a short circuit! The Australian "magpies" are stocky, black and white birds about the size of a small crow. They too have a hooked beak, but feed mainly on large insects they catch on the ground. These birds, with their loud, flutelike voices, are considered by some the best feathered songsters in Australia. Bold, aggressive birds like the rest of the family, they are particularly truculent at nesting time, often attacking anyone who approaches the nest.

The Piping Crows or Currawongs, *Strepera,* are the largest members of this family (Cracticidae). The name "currawong" is an imitation of their loud notes. They are fond of fruit and often destructive about orchards. Most currawongs have white patches in the wings or tail, but some of them are almost entirely black, reminding us very much of crows.

ORIOLES—YELLOW AND ORANGE

We have orioles in America, but the "true" orioles—those of the family Oriolidae—are an Old World family of brightly colored, mainly yellow and orange birds. Some of the more abundant and more colorful of the thirty-two species like to perch on high limbs about farmlands and in semi-open rolling country. It frequently happens that they are the most obvious and familiar birds of the landscape, especially as we often see them in flocks. However, some orioles are very shy, preferring to dwell in the cloistered seclusion of the thick canopy of tropical and subtropical jungle.

As we have indicated, these orioles are not at all related to the American orioles. This Old World group dwells in Africa, Eurasia, Indo-Malaya, Australia, and on islands of the Western Pacific. Robin-sized birds with long wings, they have rather weak legs and feet, and a prominent bill. Their flying is strong, direct, and heavy. Orioles have a clear, melodious call, though sometimes they resort to a rasping note of warning. They feed on fruit and insects.

Female orioles follow the familiar pattern of being far less brilliantly colored than the males. The Black-naped Oriole, *Oriolus chinensis,* is an interesting case in point. The adult male has a golden body, while the female and young are strongly tinted with green. The best-known member of the family is perhaps the Golden Oriole of Europe, *Oriolus oriolus,* with its golden-yellow body and black wings. The Isabella Oriole, *Oriolus isabellinus,* and the White-lored Oriole, *Oriolus albilorus,* are typical of the species that dwell in the Philippine mountain forests. Both are small yellowish birds with olive markings; they are very little known because of their elusive habits.

CROWS AND JAYS—CLEVEREST OF BIRDS

Crows and ravens are able to maintain their numbers in many places where every man's hand is against them. Indeed, many naturalists consider these resourceful birds the most highly evolved and the cleverest of all feathered creatures. Crows and ravens, the largest members of the family Corvidae, have entered many parts of the world—Australia and the Hawaiian Islands, for example—where other birds of the family, such as jays and magpies, have failed to gain a foothold.

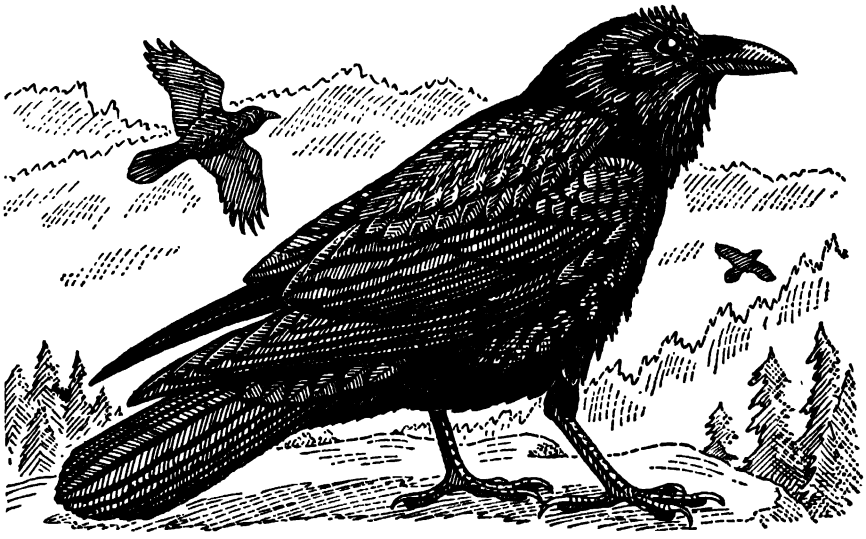
You have probably heard of the ability of some tame crows to learn to speak a few words. There is a popular belief that you have to split a crow's tongue before it can talk, but this notion is false. Crows are mischievous birds, fond of pranks, and they make amusing pets. They have been known to pull clothespins off wash lines. Bright objects have an irresistible attraction for them, and they sometimes hide away metal and glass objects. They are given to breaking up the nests of small birds, and their fondness for corn and farmyard eggs makes them the farmer's traditional enemy. However, they eat a good many insects, as well as small mice, rats, and young rabbits. The

crow has a sizable wingspread—about three feet—and is a splendid flier. It flies in a straight line—hence the proverbial expression, "as the crow flies."

The American Crow, *Corvus brachyrhynchos,* is a common bird throughout most of America. During spring and summer it scatters in pairs or small groups over the country, but in winter—it is not much of a migrator—immense numbers congregate each night to roost. By day they spread to a distance of twenty or thirty miles from the roost to glean any edible matter, vegetable or animal, that they can find. The crow is a very shy and suspicious bird and, aside from man, has few enemies. The great horned owl sometimes seizes a roosting crow at night and is, in turn, unmercifully mobbed by frantic flocks of crows whenever they find its daytime retreat.

RAVENS AND ROOKS

The Raven, *Corvus corax,* is found throughout the Northern Hemisphere. Famous for its jet plumes and dismal croaking, this bird was symbolic of ill fortune and death long before Edgar Allan Poe wrote



THE RAVEN—INTELLIGENT AND ADAPTABLE

Noted for its ingenuity when it comes to obtaining food, the raven is also remarkably adaptable to a variety of conditions. It is equally at home in deserts, high mountains, or the Arctic region, and is a destroyer of rodents and insects on a large scale. Captive birds show intelligence and may learn to speak a bit, but are mischievous.

"The Raven." A bird of the wilderness, unlike the crow, it is commonest in the deserts and mountains of the West; in the East we find it locally in the highest Appalachians south to North Carolina.

The raven is among the most adaptable of birds. Some ravens dwell in the burning deserts of the Southwest, others are among the few birds capable of spending the winter in Greenland. In such regions it displays an ingenuity in securing food that is nothing short of phenomenal. One raven was observed to pull the tail of an Eskimo dog to distract its attention while a second raven darted in to snatch a morsel of food momentarily ignored by the enraged husky.

Ravens have a diet which if anything is even more wide-ranging than the crows'. Sometimes ravens feed like vultures on dead animals. Often they hide away surplus food in a crevice or bury it beneath leaves or a shallow layer of soil. This is a characteristic practice of the hundred or so members of the family. Aside from the well known croak, ravens sometimes utter a gurgling sound, like water coming out of a jug, when they soar to a great height.

The Rook, *Corvus frugilegus*, is the most familiar bird of the crow tribe in England. A colony of a thousand birds may nest in a grove. If they see a man with a gun, they fly off their nests with much cawing. Once a year, during the nesting season, a "rook shoot" is organized to keep their numbers within reasonable bounds.

JAYS—BOLD AND JAUNTY

The Blue Jay, *Cyanocitta cristata,* has a conspicuous crest and attractive blue and white plumage. This jaunty-looking bird is common throughout the eastern United States. In parts of the West it is replaced by its cousin the Steller's Jay, which has more uniform, darker-bluish plumage.

Blue jays are bold creatures, as you can tell when you hear their noisy screams as they roam through the trees in search of food. Always ready to mob a sleepy owl or to follow and torment a fox, they eat almost anything—insects, grain, fruit, and acorns. In the spring they add the eggs and young of small birds to their bill of fare. Although some blue jays migrate, their unusually extensive diet makes it possible for many of them to winter in the north. Against a landscape of snow and evergreens they are especially handsome.

Both male and female take part in building the nest and feeding

the young, but only the female incubates the eggs. This is generally true of all the birds of this family. While the female blue jay is incubating the eggs, she is sometimes fed by her mate. The substantial nest is built of sticks, lined with finer materials, and the four or five eggs are mottled with gray and brown. Blue jays hide their nest carefully, and they are quiet and furtive in its vicinity unless danger threatens—then they sometimes launch a courageous counterattack.

In the Southwest, the best-known jay is the Scrub Jay or California Jay, *Cyanocitta coerulescens*. Though lacking the blue jay's crest, it is rather similar in habits and even more partial to the eggs of other birds. The Florida Jay, an exceptionally fearless and inquisitive bird found locally in Florida, is an eastern form of the scrub jay.

Clark's Nutcracker, *Nucifraga columbiana*, is a black and white bird you can see only if you visit the Rocky Mountains. It has a harsh, grating call that can be heard for quite a distance. As you can gather from its name, this bird cracks nuts with its heavy, pointed bill. The nutcracker nests high in the mountains early in the spring when the ground is still covered with several feet of snow. It builds a very thick walled nest and lines it warmly with fur and feathers.

MAGPIES

The colorful, long-tailed magpies are best represented in the Orient, but the Common Magpie, *Pica pica*, has entered North America by way of Siberia and Alaska and is common in the arid western parts of the continent. A handsome bird of white and shining bluish-black plumage, it has a partiality for young birds, including poultry and game birds, that does not endear it to the rancher. The magpie builds a large domed structure with a side entrance, lining the walls with mud.

WATTLE-BIRDS—NEW ZEALAND ODDITIES

It is curious that this group of New Zealand birds contains three species that show little resemblance to each other, aside from the common feature of a small wattle on the side of the head. Particularly striking is the difference in the shape of the bill. The most remarkable of these species, the Huia, *Neomorpha acutirostris*, is now almost extinct. It is unique among birds of the world for the degree of difference between the bill of the male and the female. The male's bill

is stout and only moderately curved; the female's is much longer and more slender. They make a good team—the male uses his strong bill to dig away bark and soft wood, exposing the burrows of grubs, which his mate then picks out with her slender bill.

The huia is a crow-sized black and white bird with a long tail. Like the other two species of the family Callaeidae, it has weak wings but long, powerful legs. Thus it is able to thread its way through the dense New Zealand bush by a series of long hops, sometimes aided by a flip of the wings.

The Wattled Crow, *Callaeas wilsoni,* is a grayish bird with a short, heavy bill—quite unlike the huia's. The third species, known as the Saddleback because of its chestnut-colored back, is much smaller. Both the wattled crow and the saddleback still exist in New Zealand, though their numbers are greatly reduced.

BIRDS OF PARADISE—NEW GUINEA'S WONDER-BIRDS

It is doubtful whether the marvelous colors and bizarre ornaments of birds of paradise can be matched by any other living creature, with the possible exception of the hummingbird. The accessory plumes of these birds vary from slender bejeweled rackets and flags to feathers resembling the daintiest lace. So far as we know, the first bird of paradise to appear in Europe was brought back to Spain in 1522 by Captain El Cano, Magellan's successor on his celebrated globe-encircling voyage. He obtained this unbelievably beautiful creature on the island of Tidore in the Moluccas, where the natives called it *manukdewata* ("bird of the gods").

Soon the lovely bird inspired a series of imaginative tales—it was said to gaze perpetually into the sun, and to carry its young among the soft feathers of its back. Later the observations of naturalists made it possible to separate fact from fancy. Yet we have here the kind of subject where fancy pales before fact. For centuries people believed that these exquisite birds were wanderers from the realms of heaven itself. The legless state of the early skins that filtered into Europe was partly responsible for this myth; above all, these birds came from the unknown and were truly of unearthly beauty. Yet, once the "prosaic" naturalists got to work, they discovered a fact which is more fantastic than all these myths: The bird of paradise is a resplendent relative of that somber bird, the crow!

Until recently, bird of paradise plumes were prized by milliners; no woman, whether princess or cabaret queen, considered a wardrobe complete if it lacked these plumes. So insistent was the demand that collectors poured into the forbidding and often deadly jungles of New Guinea—the principal home of the birds of paradise—to reap a harvest of skins which, in the peak year of 1910, totaled one hundred thousand male birds.

As the relentless hunt went on, many of the forty-two species of birds of paradise (family Paradisaeidae) began to disappear, and conservationists the world over feared for their survival. Fortunately, at long last laws were passed that served to halt the feather traffic before any permanent loss was inflicted. This was the end of a trade which, so history tells us, was started more than five hundred years ago. A curious sidelight of this laudable legislation is that many New Guinea settlements became virtual ghost towns and the economy of the island was seriously shaken.

The old plume-hunting days seem to be forgotten today. There is very little poaching. Even during World War II, when thousands of soldiers bivouacked for extended periods amid the very trees in which birds of paradise flourished, very few of these beautiful creatures were seen, let alone killed. The native tribes are permitted to kill all they wish for dance decorations and the like, and they extract quite a toll in the highlands where plumes are still more valuable than gold in the native economy. Other than these and the few taken by occasional scientific collectors, no birds are killed; most of the species are now flourishing.

HOW THE BIRDS LIVE

Birds of paradise feed on fruit, berries, seeds, and insects taken from a wide variety of forest habitats. These may be at sea level, or they may be at an altitude of twelve thousand feet in the mountains. The Yellow-wattled Bird of Paradise, *Macgregoria*, lives in the subalpine forest that begins at about ten thousand feet. Some birds of paradise are equipped to pick food from bark surfaces, or to dig in rotten wood to which they cling like woodpeckers; others probe in wet moss in the cloud forest for insects, and still others feed on insects from flowering trees of the forest canopy.

Some birds of paradise are as small as thrushes, others are the size

of a small crow, but with very long tail plumes. A few are surprisingly rather somber in color, with the male resembling the female, this is true of a group known as the manucodes. The fact that the males help their mates with the nesting duties is another indication that the manucodes are a primitive group.

However, we are naturally more interested in the brighter-colored birds of paradise—the plume birds. Among all these the males have elaborate courtship displays, given usually on jealously defended tree locations but sometimes on the ground. The females are attracted only briefly to the males and then build a nest and raise a family entirely unassisted. The nests are loosely constructed, though sometimes they may be bulky, open cups placed at varying elevations up to ninety feet. The eggs are notable for the streaklike brown markings that run almost from one end of the egg to the other.

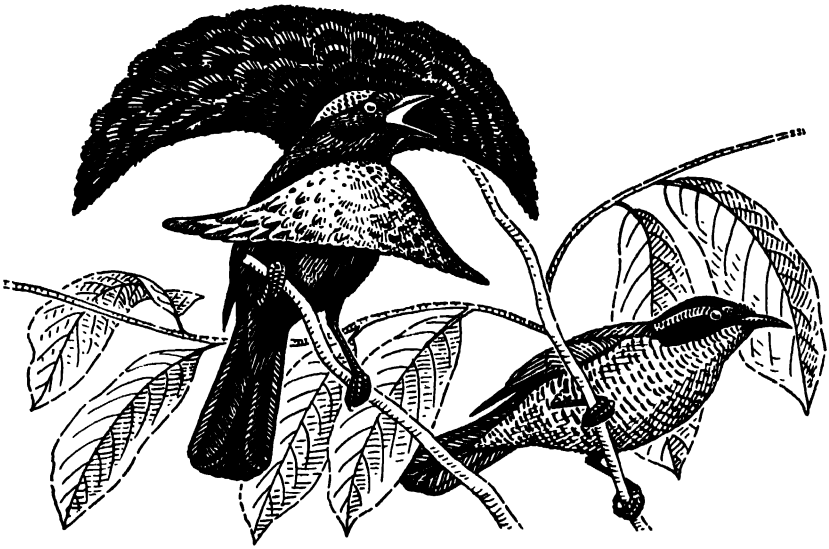
FAMOUS BIRDS OF PARADISE

Among the more typical birds of paradise, the male is excessively ornamented with plumes and often brilliantly colored as well. The female is somber in color, and she lacks accessory plumage. We see this well exemplified in the great tailed birds of paradise, *Astrapia* and *Epimachus;* the dark-colored, highly iridescent males have lengthy tail feathers which are sometimes black, sometimes nearly pure white, while the females are short-tailed, brownish creatures.

The Sickle-billed Bird of Paradise, *Epimachus meyeri*, dwells in high mountain forests. The male is a dark-grayish bird with lacy flank plumes, a long, curved bill, a massive, glossy-edged chest-shield, and a long spearlike tail. The female is maroon above and gray-barred below.

When we come to the fabled Ribbon-tailed Bird of Paradise, a glittering, green-headed black bird known only from the highlands of Mt. Hagen, we find that the tail of the adult male reaches a length of thirty-nine inches—or more than five times the length of the body! A curious feature of these birds is that in adult males the tail is pure white with narrow black tips, while in the immature male the tail has the black tips sometimes extending over a third of its length. Younger birds have variable amounts of white, or none at all—a factor which has led to much confusion; in the black stage, they

closely resemble the immature Princess Stephanie Bird of Paradise, *Astrapia stephaniae,* which dwells at similar altitudes. The two hybridize freely.



THE SUPERB BIRD OF PARADISE

This magnificent bird has a large cape of specialized feathers which covers its entire back. On its breast it has a shield glowing with a metallic luster like a brilliant medallion. To attract a mate, the male perches on an exposed tree limb and utters rasping notes. He then makes his display, erecting the cape like an Indian headdress and opening wide his mouth, which is aqua green within.

The Greater Bird of Paradise, *Paradisaea apoda,* is perhaps the best-known member of the family. Its scientific name means "bird of paradise without feet" because the first trade skins brought to Europe had had the feet removed. We were fortunate enough to observe these birds in southern New Guinea in 1948; we found them traveling in bands through the upper tier of the virgin forest from near sea level to altitudes of five thousand feet.

The male is jay-sized, but because of his greatly elongated flame-colored plumes, he appeared as large as a crow. The head is straw yellow, the forehead and throat gleaming green, and the chest deep maroon. The female is rather similar in size, drab brown, and she lacks the plumes. Morning and evening, bands of these birds travel through the forest on regular routes to favored dancing trees on the

forest edge or on the crests of small ridges. There a male displays on a previously selected stage which he defends against other males who congregate to watch from the sides. They flap their wings together over the back as they hop, all the while keeping up a raucous chorus of crowlike and guttural calls and appearing resplendent in the rays of the rising or setting sun. The purpose, of course, is to attract females to the tree. Females—of which there is always a large following—select a resplendent mate with the same noisy deliberation that some housewives select a new hat.

A professional plume hunter of other days whom we visited in Papua said he had collected nine hundred males of this very common lowland species in 1908. He sold them to a Dutch trader at Port Moresby for one pound sterling each. The bulk of 28,300 skins of birds of paradise, which made up a single shipment to a British concern in 1912, was doubtless of this species; yet even such wholesale slaughter failed to have any lasting effect.

The Blue Bird of Paradise, *Paradisaea rudolphi,* a rare and beautiful bird, lives higher in the mountains. Skins of the male of this bird sold for twenty-five pounds apiece in 1908, but very few, if any, were offered for sale. Their high price was due not only to their beauty but to the inaccessibility of the country where they lived.

This bird has a velvety black body, the bill and eye-ring are white, and the wings and tail are opalescent blue. The flank and abdomen plumes are gorgeously tinted with lavender, purple, and blue, and have the texture of delicate lace. The abdomen is streaked with maroon. Black plumes, two feet long, each tipped with a jewel-like spot of opal, spring in great fixed curves from the base of the tail. The brownish female is plumeless and has blue wings.

We were lucky to find a ridge of rain forest high in the Owen Stanley Mountains, which was thickly populated with these magnificent birds. In little jungle clearings solitary females were found perching twenty to forty feet up and usually several hundred yards apart. Throughout the day they emitted a rasping, explosive call apparently answering a male that occasionally called "co-lee, co-lee" from high overhead. Like several others of the richly plumed birds, this species displays from a pendulous position, hanging straight down from the perch and thus permitting the fanlike plumes to open up to their fullest splendor.

The Twelve-wired Bird of Paradise, *Seleucides ignotus,* another famous bird, lives in lowland sago swamps. As you can gather from the name, the male has twelve wirelike spines, each about a foot long and sharply bent, which spring from the tips of the fragile lemon-yellow flank plumes. Except for the iridescent purple wings, the body is greenish velvety black, brighter on the back. On the chest there is a blackish shield forming an oval background in which the head may be centered and displayed. Curiously enough, the inside of the mouth in the male is greenish cobalt blue and the iris of the eye is scarlet, while in the female these parts are pale yellow. A twelve-wired bird of paradise lived for more than twenty years in the New York Zoological Park.

The Six-wired Bird of Paradise or Flagbird, *Parotia lawesi,* is an incredible creature. One, which we collected in the high mountains of Papua, was velvety black above with bluish-green reflections on the crown, whitish tips on the forehead and chin, metallic green on the throat, sides of the face, and chest, and with a distensible hooplike skirt of long feathers springing from the lower chest. When erected, this dress almost encircled the bird and concealed all of the body and legs below the chest. This species cleans a small bit of jungle floor and this it uses for its display and mating dance.

MacGregor's Bird of Paradise, *Cnemophilus macgregorii,* to date encountered exclusively in the highlands of New Guinea, is every bit as bizarre and highly pigmented as the cock-of-the-rock of South America. It is bright gold, heavily washed with scarlet. Its crown is adorned with six curious plumes projecting upward from the base of the bill in Hattie Carnegie fashion. We have taken this strange bird from the forest crown at altitudes between 7,500 and 11,000 feet. Until a short while ago, the creature was generally supposed to be a bowerbird.

The King of Saxony Bird of Paradise, *Pteridophora alberti,* is the most amazing member of this fascinating family. It has two tremendously long wirelike plumes springing from the sides of the crown. Each is decorated with thirty-five or so waxy flags, all growing like giant sawteeth from one side of the shaft. Sky-blue in color, they have an enamel-like surface. The bird itself is something of an anticlimax, being rather like a thrush. It is velvety black above and on the

throat, with a pronounced shoulder cape and a vivid egg-yolk-yellow abdomen.

What use the King of Saxony made of its bizarre plumes remained a mystery until very recently. We had the good fortune to discover this exceedingly rare bird on its home grounds in the central highlands of New Guinea in 1950 and to study and photograph the courtship dance of the male.

The King of Saxony bird of paradise displays on a thin limb tip forty to seventy feet up in a primeval sentinel tree in thick forest. In mountains bordering the Wahgi Valley we found such perches at altitudes from 7,300 to 8,500 feet. The display consists of rapid dancing and graceful bowing toward the female. She is apparently first drawn to the dance arena by an intermittently delivered, explosive, hisslike call. As the male undulates rapidly, his plumes arched and quivering over his back, he slowly bows to the female. She approaches nervously to within a foot and a half of the resplendent male. In bowing, the enormous head quills slowly sweep forward over the lowered head until they protrude menacingly like the horns of an infuriated bull. (This comparison may seem out of place in describing the bird of paradise, but it suggests itself irresistibly to the observer.) Following several more bows, the birds reach their highest pitch of excitement; the male again delivers his explosive call, at the same time leaping freely upward about eighteen inches and then flying off with the female.

BOWERBIRDS—GREATEST BUILDERS OF THEM ALL

Relatives of the birds of paradise, bowerbirds are noted above all for their building of bowers. These structures are basically places where the males display to attract mates; but building bowers is so ingrained that the birds apparently devote much time to it, even during the seasons when they are not nesting. They place the true nests some distance away from the bowers; these nests are not remarkable in any way.

Bowerbirds do not have the ornamental plumes of the birds of paradise, but some of them are brightly colored. Thus, the male Regent Bird, *Sericulus*, has a pattern of rich orange yellow and black. The male Satin Bowerbird, *Ptilonorhynchus*, is deep blue throughout; even his eyes are blue and kept wide open and bulging when

he is displaying to his mate. A few members of the family Ptilonorhynchidae lack bright colors altogether. Eight species of bowerbirds dwell in Australia and about an equal number in New Guinea.

OUTSTANDING BUILDERS

The builder of the most elaborate bowers is the Golden Bowerbird, *Prionodura newtonia.* A typical bower consists of an archway or bridge built of interlaced vines and stems. Its walls are ornamented with berries, ferns, and mosses. Two piles of sticks, one at either end, support the bower, which covers several square feet.

Among other species the bower is often ornamented with shells, bits of glass, or any brightly colored object the bird can find. One species covers its display area with green leaves, picked fresh each morning. But most remarkable of all is the "painting" of the walls of its bower by the satin bowerbird. In the wild it uses black earth, ashes, or colored soil, mixed with its own saliva and applied with a bit of frayed bark. The following account of the behavior of one of these birds in captivity was published by Dr. Crandall, Curator of Birds at the New York Zoological Park.

"In February, 1922, a keeper called my attention to the antics of a satin bowerbird, which followed him about the aviary, nibbling at the soft wood of a sieve the man was using. I watched the bird for some time, and finally discovered that the particles of wood were 'chewed' until they had become thoroughly mixed with saliva, and that the resultant paste was smeared on the twigs that lined the inner walls of the bower. A piece of dry rotten wood was then placed in the cage and an orgy of plastering followed. When the deposit had become dry, we found that most of the inner twigs were well covered with a thick grayish coat of crumbling consistency."

This painting, in which, as we have noted, a bit of bark or wood is sometimes used as a "brush," is one of the very few authentic instances of the use of a tool or implement by a bird or, for that matter, by any animal below the human level. Perhaps the only other example is the use of a twig by one of the Galápagos finches, to poke out insects.

The Gardener Bowerbirds, *Amblyornis,* are better known, and justly famous. Most of them are brown and quail-sized, with enormous

golden-orange crests. In 1950 we came across the bower of one of these birds, *Amblyornis macgregoriae,* in central New Guinea, nine thousand feet above sea level. The bower was constructed of twigs placed around a sapling, in deep forest, to a height of nearly four feet. The bird-architect had thus formed a slender wooden Eiffel-Tower-like structure. About its base every vestige of debris for a diameter of three feet had been cleared away and the immaculate arena thus formed was cloaked in fine-textured moss. Around this area circled a mossy wall several inches in height. We saw the attentive male flicking the massive golden crest over his head and heard him emit resonant crackling sounds and deep ventriloquistic notes.

This bird lays a single pale-buff egg, in June or July, in a strong cup nest of wiry rootlets encased in dried leaf. The structure is hidden low in a small forest tree.

Sanford's Bowerbird, *Archboldia papuensis sanfordi,* dwells in the central highlands of New Guinea. It is a jay-sized black bird with a long rakish golden crest. The female is brownish black. Gilliard discovered this remarkable creature in July, 1950. Naturalists know nothing of the bird's life history, aside from the fact that it makes a dance ground of withered fern fronds in fern-clad forest at eight thousand feet or thereabouts.

The dance ground we discovered was surrounded by more than fifty empty snail shells and by piles of beetle skeletons. Several of the birds we examined had been feeding on bluish berries. Our eleven male and female captives were all trapped at the same meeting ground during a fifteen-day period.

BOOK III: Amphibians and Reptiles of the World

CHARLES M. BOGERT



Amphibians, Pioneers on Land

WHERE THE AMPHIBIANS CAME FROM

AMPHIBIANS—animals that live both on land and in water—have a long past. It began ages ago, in the sea, cradle of life. Our earth, now estimated to be between two and three billion years old, was not exactly in its infancy when the first backboned animal made its way to land. This great pioneer was a fish, and it parted company with other fishes some 340 million years ago, to become the forefather of our modern frogs and salamanders.

The change from a water-dwelling animal to one that could live on land required much time. Limbs had to develop from fins, and lungs from an air bladder, which in the fish ancestor may already have been used for breathing. Indeed, the existing lungfish of Africa—a strange fish that breathes with lungs as well as gills, and can survive for months out of water—gives us an inkling of how the first amphibian acquired the ability to leave the sea. Nevertheless, all modern amphibians—scientists group them in the class Amphibia—still pass through a gilled stage, even though the offspring of a few kinds lose their gills before they come out of the egg.

There are several reasons why water is important in the lives of all amphibians. They lay their eggs either in water or in some moist place. Their skin is especially suited to their double life, being constantly moist—whereas reptiles on land have a dry, scaly skin

(There are other interesting differences between amphibians and reptiles, as we shall see later on. Reptiles lay their eggs on land; they depend on sunlight to heat their bodies; their food requirements are much smaller than those of amphibians.)

Coming back to the amphibians, we find that tiny glands in their skin produce a slimy substance: mucus. This makes it possible for the amphibian to "breathe" through its skin as well as through its gills or lungs. Indeed, some salamanders have neither gills nor lungs and breathe largely through the lining of the mouth and throat and their skin. On land, unless the surrounding air is filled with moisture, water from the mucus covering the skin evaporates, causing a toad or a salamander to be colder than the air or the ground beneath it. Amphibians get all the moisture they require through the skin, by entering the water or by simply absorbing it from wet earth; but they do not drink, nor can they absorb moisture from a humid atmosphere.

The first land-dwelling backboned animals retained the scaly body as well as some other characteristics of their fish ancestors. The fossils we have found suggest that amphibians had been on land for some time before their scales were replaced by the glandular skin that most of them now have. We know that traces of the scales of the pioneer amphibians are hidden in the skin of some of the superficially worm- or eel-like caecilians. These are strange limbless amphibians restricted to humid regions in the tropics.

With no other backboned animals on land to dispute their claims, the earliest amphibians seem to have thrived in their new environment. Their limbs became stronger, and their backbone took on the structure needed to carry the weight of a body no longer supported by the buoyancy of the water. They grew in size, without ever becoming real giants; they probably never produced anything so large as a ten-foot alligator. But for a time the amphibians were the masters of the solid earth. They reached their peak of abundance some 200 million years ago—140 million years after emerging from the sea. It was about this time that one progressive group began to develop into reptiles.

WHERE AMPHIBIANS LIVE

Amphibians did not dominate the earth for long, and most of those now in existence are relatively small. But we cannot call them an un-

successful group, for they have managed to invade nearly all parts of the earth, except the seas and the Arctic regions. Despite their need for moisture, toads have even entered the deserts.

Nearly one-tenth of the twenty-five hundred known kinds of amphibians live within the borders of the United States. Fewer than forty are recorded for the whole of Europe, the best explored of the continents. Those in the vast tropical rain-forest areas of Africa and South America are not so well known. Such regions as the Amazon basin of South America and the Cameroons in Africa are teeming with frogs, in such numbers that it may be years before all the kinds living there are found and classified.

THE THREE GROUPS OF AMPHIBIANS

We readily separate modern amphibians into three main groups: frogs, salamanders, and caecilians. The caecilians lack a satisfactory common name because few people get to see them in the tropical regions where they live.

Frogs are the most abundant of the three and are easily recognized in the adult stage because they have no tail. (It disappears when they grow out of the tadpole stage.) On land they move by leaps and jumps. In fact, their group name *Salientia* is derived from the Latin word meaning "to leap."

Salamanders, unlike frogs, keep their youthful tail throughout their lives. In this respect they more closely resemble the earliest "fish on land." As a rule they crawl or walk on land, instead of leaping or hopping. In the water, however, salamanders propel themselves with their tail. Two species of salamanders that never venture on land, have lost their hind limbs completely.

Only the caecilians have no limbs at all. Those that live in water swim like eels, with sinuous movements of their body. Others are limited to moist areas, mostly in tropical forests, where they crawl about like burrowing limbless lizards. If not examined closely, they could be mistaken for earthworms. Most caecilians are a foot or less in length; but one kind has a snakelike body five feet long.

After this brief survey of 340 million years of amphibian life, we turn to the fascinating details of amphibian existence among the two leading groups—the salamanders and related creatures, and the tailless amphibians, the frogs and the toads.

Salamanders, Hellbenders, Newts, and Their Relatives—Amphibians with Tails

ALL SALAMANDERS have tails. This feature alone is enough to distinguish them from frogs. Many salamanders begin their existence in the water, where the female lays her eggs. Legs appear early in the life of the larva (the young, immature animal). Except for the gills, which extend on each side at the back of the head, the larva closely resembles its parents.

Larval salamanders, the young ones with gills, have true teeth. In this respect they also differ from tadpoles (larval frogs), which have a black beak and several rows of tiny horny combs to scrape off food.

Salamanders ordinarily have four toes on their front limbs and five toes on their hind ones. A few salamanders have lost some of their toes. The Mud Sirens, *Siren* and *Pseudobranchus,* of southeastern United States have completely lost their hind limbs. In the same general region of the United States, the great eel-like salamander known as the Congo Eel, *Amphiuma means,* has both pairs of limbs so reduced that only two toes remain.

When a toad loses a leg it is forced to spend the rest of its life without it. The salamander is better off in this respect, for it can regenerate or regrow lost limbs. The salamander can also regrow a lost tail. Only two kinds of reptiles can do this: the lizards (with some exceptions) and the lizard-like creature known as the tuatara.

Salamanders resemble frogs in having a moist skin filled with tiny glands. In some newts—*Triturus,* for example—these glands produce a poison that discourages enemies from eating the newts. Other glands give off a mucus or slime that makes the animal slippery and difficult to hold. When the salamander is on land, water is constantly being lost from this mucus through evaporation, unless the air

is saturated with moisture. That is why most land-dwelling salamanders are found in regions where there is abundant rainfall. Such places as the cloud-shrouded mountains of Virginia, Tennessee, and the Carolinas are salamander havens. But even there salamanders prefer to venture forth only at night.

Salamanders, hellbenders, newts, and their relatives comprise the order Caudata (creatures with tails).

WHERE SALAMANDERS LIVE

Salamanders live in ponds, lakes, rivers, creeks, and brooks. They also dwell in underground waters and in caves, on mountains and hillsides—even in tree cavities. But salamanders do not live in deserts, for in order to "breathe" through their skin, they need a moist atmosphere. A few amphibians live in brackish water, but there are no sea-going frogs and salamanders.

There are more kinds of salamanders in North America than in all other parts of the globe combined. Over 125 species and subspecies occur in the United States alone, and there are many more in Mexico. There are quite a few kinds in Europe and Asia, but none in Australia and only three in Africa.

Salamanders shun bright light and dry air. Except for the newts, it is unusual to find them abroad during the daylight hours. They can ordinarily be found in moist places under rocks or logs. A few live in caves, where they crawl about the walls in search of millipedes or such insects as mole crickets. In the Dixie Caverns near Salem, Virginia, Mr. Clifford H. Pope and Dr. James Fowler found the Dixie Salamander, *Plethodon wehrlei dixi*, crawling about on the stalactites in such abundance that scores of them could be seen at one time.

In Kansas, Missouri, Arkansas, and Oklahoma the Ozark Blind Salamander, *Typhlotriton spelaeus*, is so fond of caves that the adults are never found elsewhere. No light penetrates the dark inner recesses of the caverns. The salamanders' eyes, of no value under such conditions, are reduced to remnants. However, if reared in the laboratory where light is provided, they retain their eyes.

As for the larvae, they have turned up in streams outside, as well as in the underground passages. They have normal eyes and are not unlike the gilled larvae of other salamanders that begin life in the water. They mature, lose their gills, and crawl about the walls.

Scientists believe that such salamanders retire to caves in order to escape the heat of summer. With few exceptions, notably the Newts, *Triturus,* salamanders cannot tolerate high temperatures.



The adult Ozark blind salamander spends its life in pitch-dark caverns. As a result of disuse, its eyes gradually turn into mere remnants. Yet the offspring, if reared in surroundings with enough light, turn out to have normal eyes.

Salamanders, unlike snakes and lizards, prefer low body temperatures, and some kinds can remain active when scarcely above freezing. Those living in cold regions can survive being frozen within a block of ice, even though a body temperature two or three degrees *below* freezing would kill them. The Mount Lyell Salamander, *Hydromantes platycephalus,* habitually lives at high altitudes in the Sierras

of California. It is often found active in water melting from snow banks. In fact, it dies unless it is kept cold.

Because salamanders require cool surroundings, a number of species in the United States are found only in underground waters and artesian wells. Two kinds of salamanders have retreated to the cool underground waters in the southern part of the United States. With the waning of cold climates in that region, they may have been stranded in surroundings warmer than they could tolerate on the surface. Glaciers never covered all of Texas as they did New England, but it may have been much colder where the Texan Blind Salamander, *Typhlomolge rathbuni,* now lives in some of the artesian wells of the Lone Star State. And the Georgian Blind Salamander, *Haideotriton wallacei,* which was discovered in the water from a deep well in Dougherty County, Georgia, may at one time have found life tolerable on the surface.

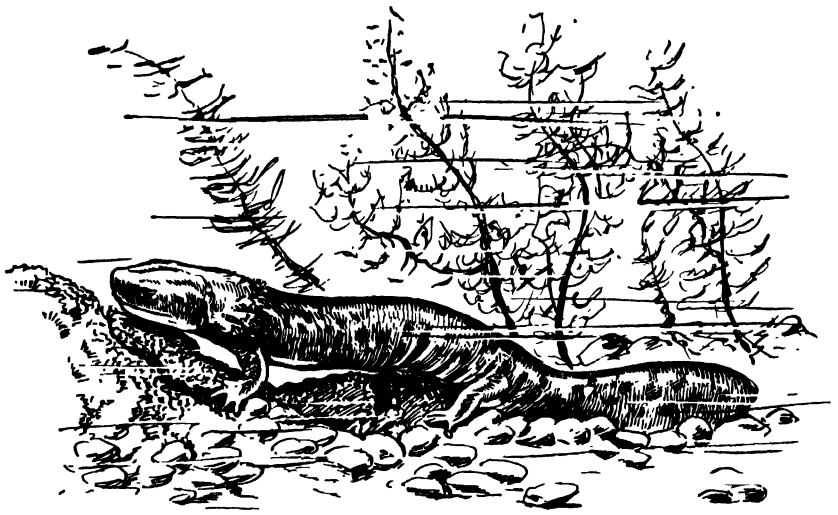
Both of these underground-water salamanders have a pale, ghostly appearance. Like the Ozark blind salamander they have only the barest remnants of eyes, well hidden below the skin. They differ from it, however, in that they never lose their gills. It is extremely doubtful whether they ever leave the water, and little is known about their breeding habits. In fact, the Georgian blind salamander was unknown until 1939 when a single specimen came into the possession of my friend and colleague, Dr. A. F. Carr, of the University of Florida. It may be years before another individual is brought up from the depths of the same well or from others in the vicinity.

HOW SALAMANDERS BREATHE

The ways of breathing of the salamander family vary greatly. While all the larvae use gills for breathing, some adults have lungs, some have gills (like fish), and some have neither, breathing only through their skin and the lining of the mouth and throat.

In addition to the underground dwellers, the Mud Puppies, *Necturus maculosus,* their close relatives, and a few other salamanders keep their larval gills into adulthood. They live in lowland streams, or even lakes, throughout most of the United States east of the Rocky Mountains, and they are sometimes well over a foot long. The main branches of their gills are covered with hairlike filaments that give

them a furry appearance. Blood is carried in through tiny vessels or capillaries into each filament, where oxygen from the water enters the blood. Waste matter leaves through the same filaments. Salamanders living in stagnant pools where there is little oxygen in the water, tend to have more elaborate gills than those living in swift-moving, well-aerated mountain streams. The pond dweller will often have a fin on its back and tail, probably also to make breathing easier. For "breathing," as we know, is carried on through the skin as well as the gills.



THE MUD PUPPY KEEPS ITS YOUTHFUL GILLS

Many salamanders start life in the water, and consequently have gills. Later on, as they pass out of the larval stage, they may acquire lungs or breathe through the skin. Others, among them the mud puppies, continue to use their gills all through life.

Some salamanders living in lowland waters—permanent streams, ponds, or lakes—lose their gills; others keep them. The Great Hellbender, *Cryptobranchus alleganiensis,* has gills as a larva, but loses them early in life, even though a gill slit remains on the adult. The fully grown hellbender has lungs but mostly uses its skin for breathing. Similarly the Congo Eel, *Amphiuma,* keeps its gill slits even after outgrowing its gills. But in the Sirens, *Siren* and *Pseudobranchus,* the gills are outside the head and usually are quite conspicuous throughout life.

Among the Tiger Salamanders, *Ambystoma tigrinum,* there are

some that may or may not lose their gills. Curiously enough, the Northwestern Tiger Salamander, *Ambystoma tigrinum melanosticum,* is known to breed when still having the outward appearance of the larval stage, with the tail fin and featherlike gills that are ordinarily lost in the adult stage. Similar larvae were first known in the lakes around Mexico City, where they were called by the Aztec name, *axolotl.* The creature attracted so much attention, and became so well known, that the name *axolotl* is universally applied to tiger salamander larvae. Some of the axolotls from Mexican lakes are able to part with their gills and become land dwellers using their lungs for breathing. But the work of the lungs is aided by their moist skin, which absorbs oxygen.

Many of the common salamanders in North America, such as the Red-backed Salamander, *Plethodon cinereus,* and Slimy Salamander, *Plethodon glutinosus,* in the East, and the Arboreal Salamander, *Aneides lugubris,* in the West, have no lungs at all. Such animals "breathe" through their skin or through other body tissues exposed to the air. If these salamanders are examined under a magnifier that enlarges them only twenty or thirty times, the corpuscles (blood cells) moving in the small blood vessels of the skin can easily be seen. The flow of the corpuscles is not steady, for the heart pumps the blood at intervals, causing it to speed up momentarily. Throat movements draw air into the mouth, the lining of which is richly supplied with blood and thus able to absorb oxygen.

Salamanders living in the oxygen-carrying water of swift mountain streams breathe mainly through their skin and require neither gills nor lungs. In fact, lungs might be a handicap because when they were filled with air, the salamanders would find it hard to stay down on their feeding ground in the stream bottom.

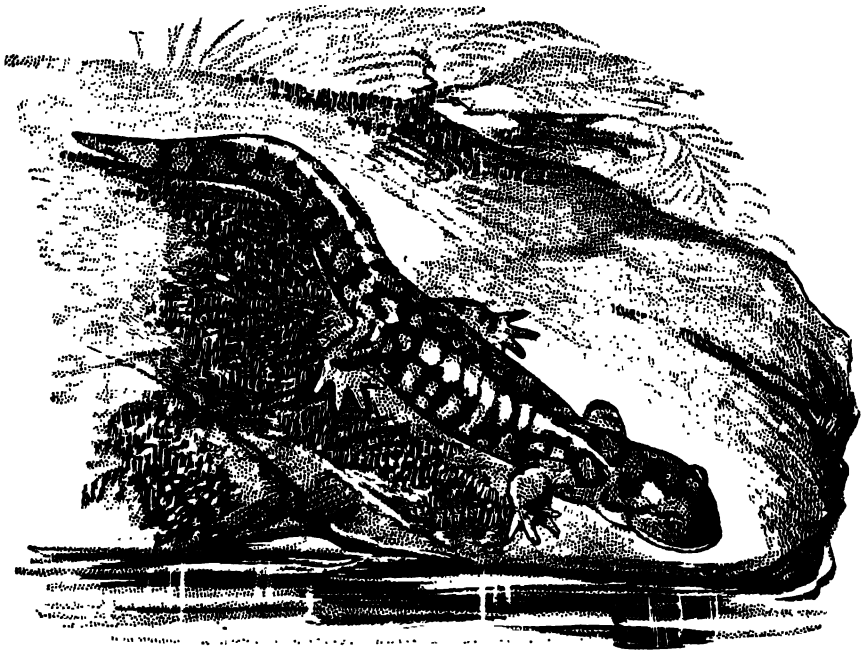
Many lungless salamanders never enter the water at all. The red-backed and slimy salamanders mentioned earlier will drown if forced to stay under water.

COURTSHIP AMONG SALAMANDERS

Among salamanders the eggs are commonly (but not always) fertilized as they are being laid. In some cases observers have witnessed courtships of great drama and elaborate ritual. These pave the way for such fertilizations.

The tiger salamanders, for example, conduct a social courtship in

which the males arrive first in a group at the breeding site. They move about rapidly in the water, rubbing against one another. This behavior apparently excites the females, who have followed the males to the meeting place, and prepares them for the actions that result in the fertilization of their eggs.



A SALAMANDER WITH WAYWARD BREATHING HABITS

Some tiger salamanders discard their gills when they become adults. Leaving the water to dwell on land, they breathe through their lungs and absorb oxygen through the moist skin. Others, retaining the gills of the larval stage, spend their adult lives in the water.

The Red Salamanders, *Ensatina eschscholtzii,* court in couples rather than in groups. The male approaches the female stealthily, crouching low as he moves toward her head. Upon reaching her, he massages her throat and snout by rubbing her with his head and neck. This is followed by the "tail walk," in which the male leads the female about, his back arched and his tail between her legs. Finally the male deposits a conical structure of jelly, capped by a packet of sperm. The female, whose throat has been pressed over the hip region of the male, moves forward with him once more. As her vent comes into place over the packet of sperm, she squats on it, drawing it into

her body. This procedure was observed and reported by Dr. Robert C. Stebbins.

HOW THE EGGS ARE FERTILIZED

The female salamander retains the sperm in small packets in the roof of her vent. The eggs are fertilized as they pass these pockets when they are deposited. In one salamander the sperm, like tiny tadpoles, move inward and fertilize the eggs in the body cavity of the parent. This would be necessary in the case of a live-bearing salamander such as the European Black Salamander, *Salamandra atra,* which retains the eggs in its body until the young are fully formed. The young are produced in similar fashion by a relative, the European Spotted Salamander, *Salamandra maculosa,* but only if it cannot reach water. Usually its eggs are laid in streams.

The Black Salamander, which bears fully formed offspring, is usually found at relatively high altitudes, on steep slopes where no pools are available.

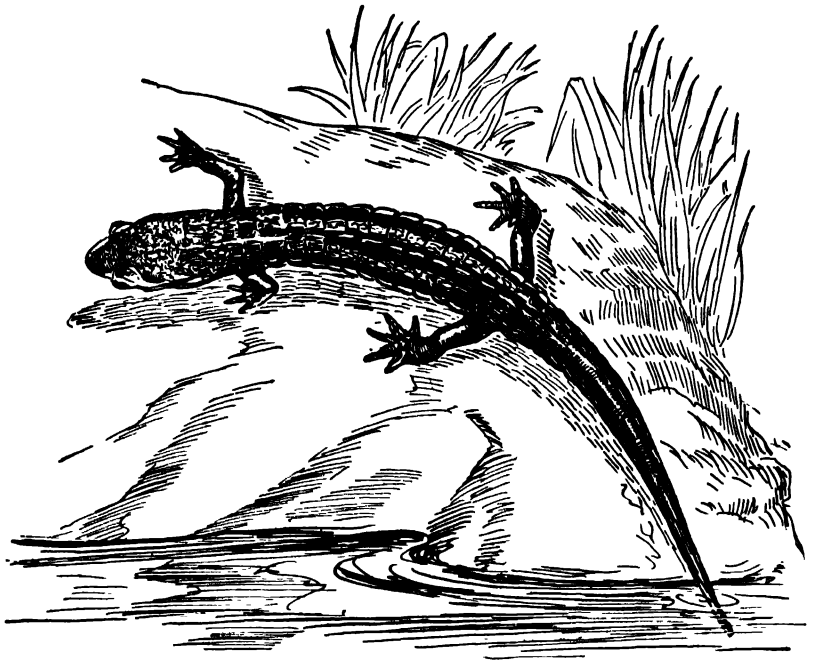
THE EGG-LAYING SALAMANDERS

The red-backed and slimy salamanders—like the Worm Salamanders, *Batrachoseps,* of the Pacific Coast from Baja California to Oregon—lay their eggs on moist ground under rocks or rotten logs. The young pass through a gilled stage inside the egg, and when they emerge they are fully formed. The red-backed salamander is often found coiled around its small clutch of eggs. The arboreal salamander deposits its eggs in the cavities of oak trees, sometimes several feet above the ground.

Salamanders living in the water ordinarily lay their eggs there. The Two-lined Salamander, *Eurycea bislineata,* lays about thirty eggs. She attaches them singly to the underside of any suitable rock in the mountain brooks that are her home. Several other salamanders that live in mountain springs or brooks follow a similar procedure. The hellbender female, with the largest eggs of any North American salamander, deposits her eggs in two long strings. The male stands by and fertilizes the eggs after they are laid, as many fishes do. The relatively huge, pale yellow yolk of each egg is about á quarter-inch in diameter, surrounded by a transparent envelope nearly three times as large.

SALAMANDERS VARY IN SIZE

Salamanders vary greatly in size. The largest known is about thirty times as long as the smallest. Japan and China boast the largest tailed amphibian in existence, the Giant Salamander, *Megalobatrachus japonicus*. This creature at times reaches a length of over five feet, thereby dwarfing its American relative, the hellbender, which rarely reaches a size of more than two feet. At the other extreme lies the



THE SMALLEST SALAMANDER

The maximum length of a pygmy salamander, tail and all, is two inches. It is a native of the American Southeast. At the other end of the scale we find the giant salamander. A creature of the Orient, it is about thirty times as long as the pygmy salamander.

Pygmy Salamander, *Desmognathus wrighti*, of the spruce-forest mountain tops in the southeastern United States; this small creature's body is barely more than an inch in length. Even with its tail included, the largest adult is hardly two inches long. The two-toed congo eel may reach forty inches, the greatest length attained by any American salamander.

THE SOUNDLESS SALAMANDER

In contrast to the tailless amphibians, salamanders, with but one known exception, have no vocal cords, and most of them are silent. True, a few squeak or produce faint noises when picked up, but this probably comes from the accidental expulsion of air from the throat in the animals having lungs. In the lungless salamanders it is difficult to explain the noise at all, unless the air is forced from the mouth.

FOOD AND FOES

Insects, millipedes, or similar small creatures form the salamander's diet. Mud puppies and newts occasionally eat fish eggs, but such thievery is unusual. On the whole the salamander leads a harmless existence, as far as man is concerned: not especially beneficial, but certainly not destructive.

House cats and other common animals prey on salamanders, as do crows. Sometimes during their nighttime prowls salamanders are seized by small owls. Other amphibians, frogs as well as salamanders, feed on them. Such fishes as bass and pike eat the larvae or the adults; catfish devour their eggs.

Throughout their lives salamanders are subject to hazards of one kind or another. And yet a few may live to a ripe old age. Tiger salamanders in the permanent larval stage have lived as long as twenty-five years. The Great Crested Newt (or Warty Newt), *Triturus cristatus*, of Europe has been kept for twenty-nine years, equaling the hellbender's record. The giant salamander of Asia exceeds all others, however, having passed the half-century mark.

THE HELLBENDERS AND GIANT SALAMANDERS

This family, which includes the largest living amphibian, is essentially a relic from millions of years ago and now contains only three species. It is doubtful whether any marked change in the habits of these animals has occurred for millions of years. All three are largely water dwellers, fishlike in much of their behavior as well as in their reproduction.

The three members of the family (Cryptobranchidae) hold the

record for age and size. They are the Common (or Great) Hellbender, *Cryptobranchus alleganiensis,* the Giant Salamander, *Megalobatrachus japonicus,* and the Ozark Hellbender, *Cryptobranchus bishopi.* The fossil skeleton of a thirty-million-year-old ancestor of one of these, five feet long, was once mistakenly described as that of a man. This ancestor lived in Europe, where no giant salamanders are now found.

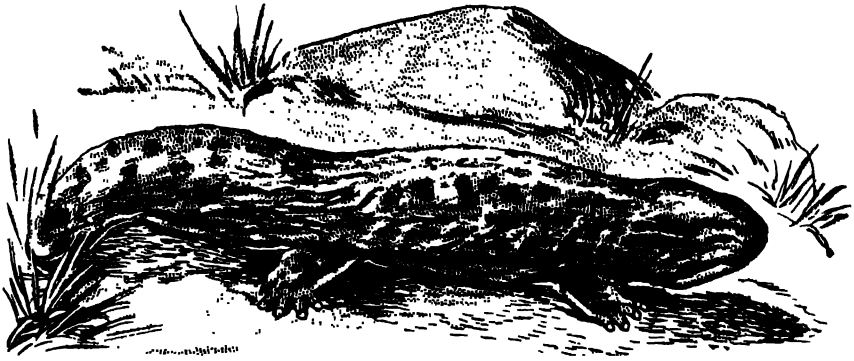
Man's destruction of the forests has caused streams to be filled with silt, making them unsuitable for hellbenders. Man has also polluted streams with sewage or other wastes, and has built dams. Thus man has done much to destroy the breeding grounds of the hellbender and its gigantic relative. These salamanders are anything but handsome, but they are interesting nonetheless. Yet within the next century they may reach the end of their long career on earth. In any event, their fame as record holders for size and age is not likely to be forgotten.

The Hellbender, *Cryptobranchus alleganiensis.* Imagine the astonishment of the angler pulling his line from the river and finding on his hook . . . a large grayish, or reddish, blotched creature, wrinkled as a dried prune, body flattened from top to bottom, tail flattened from side to side! A fish? No, for he finds four short thick limbs, with four stubby toes on the front two, and five on the hind. Then he will throw it back. As he tries to remove the ugly thing, his finger is painfully bitten by sharp teeth. Finally back in the water, the hellbender speeds agilely for the depths of the river.

Had the angler stopped to examine his "fish" more closely, he would have found a keel from the tail extending onto the body over the hips and a fleshy keel on the back side of each leg. He would have seen a wrinkled fold along the sides of the body reaching from the neck to the base of the tail, and small, lidless eyes close behind the snout and out of all proportion to the hellbender's great length, which is sometimes twenty-seven inches.

We do not know just how the common name "hellbender" originated. Probably it was invented by some early fisherman who made the creature's acquaintance on the Susquehanna River or one of its tributaries. Obviously not a fish, but quite unlike other salamanders, it must have puzzled that early fisherman. "Possibly," the fisherman may have concluded, as he watched the ugly animal swim off into

the depths, "it's a creature from hell, where it's bent on returning." Whatever its origin, the name has become widespread and, in fact, almost the only one applied to it along the tributaries of the Ohio and other rivers draining into the Mississippi as far west as Iowa. So hellbender it is—one of the more interesting tailed amphibians in North America.



THE SHY HELLBENDER

Though the hellbender is an amphibian, it does not spend much time on land. Instead, it favors large streams, where it spends the daytime in seclusion on the river bottom. At night it ventures forth in quest of food carried by the stream.

The hellbender rarely ventures on land from the rather large streams that it occupies. Few people encounter it aside from the startled fishermen whose bait attracts the creature. During the day this salamander usually remains hidden beneath rocks or other objects on the river bottom, depending largely on the current to bring food within reach. At night it ventures from its seclusion and feeds in the open water on the stream bottom.

Mr. Clifford H. Pope and I found hellbenders in the river near the town of Radford, Virginia. We had learned of the place through Dr. Paul Burch, who accompanied us to a small dam on the river. Dr. Burch had found that during the spring, and less often during the summer months, hellbenders climb out of the water and go upward over the rocks beneath the framework of the dam. Unable to ascend farther, they sometimes remain in pools. By peering into these with the aid of a flashlight we finally found our quarry.

——How the Hellbender Breeds. Whether hellbenders migrate or move up and down stream at various seasons no one knows

for certain. But some time during the latter part of August, or a bit later, the male removes the sand or silt from beneath the downstream side of a rock. In this bowl-shaped nest the females, for sometimes there are several, deposit their eggs. These are laid in two long strings, resembling strings of beads. The male, guarding the nest, is on hand at the time. From his vent he emits a cloudy, stringy substance containing the male germ cells, which fertilize the quarter-inch eggs after they are laid.

Sometimes over four hundred eggs are laid by a single female. The male may remain with her throughout the incubation period. Over two months later the larvae, now more than an inch long, are ready to escape from the egg capsule. Equipped with gills at first, they swim forth, propelling themselves with their fin-edged tail. Outlines of two toes can be seen on the front limbs, but the hind limbs are mere paddle-shaped lobes directed backwards.

——How the Hellbender Grows. The gills are not lost until nearly a year and a half later, when the larva is four or five inches long. The lungs have developed meanwhile, but they are ordinarily used only during the rare intervals when the creature is on land. The young hellbender breathes through its skin when under water. Oxygen is taken into the blood through the walls of the capillaries, tiny blood vessels that almost reach the surface along the wrinkled folds of the skin. These folds are constantly waved to carry oxygen-bearing water over the skin.

The animal continues to grow, feeding on almost any sort of food that comes its way. It devours insects and their larvae, sometimes even the eggs of its own kind. It is not full-grown for several years. The male becomes broader and heavier than the female of the same length.

Hellbenders are known to be long-lived creatures. One kept in the Amsterdam Zoological Garden was obtained in 1902 and did not die until 1931, after twenty-nine years in captivity.

The Giant Salamander, *Megalobatrachus japonicus,* the largest known surviving amphibian, is much like the hellbender in its habits. Its eggs are somewhat larger, and it lays fewer at a time. It has a prolonged infancy. Its gills remain until nearly three years after hatching and it is not able to breed until nearly a year or more later.

The giant salamander lives in mountain streams of China and Ja-

pan and is a popular food among the natives. In Japan it is found only in the higher portions of the island of Hondo. Enterprising Japanese now raise these giants commercially. Years ago Dr. Hugh M. Smith reported that people in the vicinity of Funatsu, especially women, used the meat for medicinal purposes. The meat of the giant salamander is probably wholesome and palatable, but of dubious value as medicine. Of course, large specimens are a tempting source of food, as they weigh nearly a hundred pounds.

It is probable that this giant has already been exterminated by man in parts of its range. Animals as long as five feet are becoming rare, for they grow slowly.

The fact that there are giant salamanders in Asia (also as fossils in Europe) while their only living relatives, the hellbenders, maintain an existence in the eastern part of the United States, suggests that such creatures formerly lived in many other parts of the world. It is generally believed that at times in the past there was a land bridge that connected Alaska with Siberia. The ancestors of the hellbender may well have reached North America by way of such a bridge and probably lived in much of Canada at one time. Meanwhile, changing climatic conditions and the uses man has made of the animals' native streams seem to have reduced their range to its present limits.

——THE LONG-LIVED GIANT SALAMANDER. Efforts to rear giant salamanders in captivity have not been wholly successful, although six were raised from a pair that bred in Amsterdam. These giants are seldom exhibited in the United States, but many kept in European zoological gardens have lived for years. One remained alive for about eighteen years in the New York Zoological Garden where it died in 1927. Lord Rothschild kept two giant salamanders at Tring Park in England. But because they fought if kept in the same tank, he placed them in separate tanks, where one lived forty years and the other forty-four years.

Major Stanley Flower, to whom we owe much of our knowledge about the duration of life in animals, is reasonably sure that some giant salamanders have survived as long as fifty-five years. This is the greatest age known for any amphibian. It is remarkable, as Major Flower comments, that this salamander, which normally lives in cold, running mountain streams, should thrive in small tanks.

THE NEWTS AND THEIR RELATIVES

The newt, intended captive of many a small boy dangling a worm tied to a string, is a desirable and easily obtainable small pet. You do not have to look for newts in remote woodlands. I have found them in many lakes, ponds, pools, and ditches within a few short miles of New York City. They are safe to handle and fun to observe.

The most interesting fact about the newt is that it lives a double—or rather, a triple—life. It is born in the water, where it lives a few months before losing its gills. It then lives on land for two or three years. Finally in adulthood it returns to the water to breed and live out the remainder of its life, which may be a long one. One great crested newt was kept alive in captivity for twenty-nine years.

In its middle land-dwelling life, the newt is called an "eft." Both names are derived from the old English "ewte" or "evete." "A newt" was originally a wrong division of the words "an ewte," in speaking.

The tailed amphibians included in the family Salamandridae (newts and their relatives) are at their most varied in Europe, where their history dates back nearly forty million years. The more primitive species are mostly rough-skinned, largely water-dwelling newts which some scientists place in a separate family, Pleurodelidae. The more specialized kinds, such as the misnamed "Fire-salamander" (properly the European Spotted Salamander, *Salamandra salamandra*) spend more of their time on land. The most primitive members of the family are species of the Asiatic genus *Tylotriton*, found in the eastern Himalayas, Yunnan, and Okinawa Island, which gained fame in World War II.

——WHERE NEWTS ARE FOUND. Newts are the only salamanders found in Great Britain. In the English language the term "newt" has come to be applied to several closely related salamanders—those ordinarily associated under the name *Triturus*. Members of this group or genus are widespread in the northern half of the world.

Eight kinds or species are found in Europe, seven in the United States. Many more occur in Asia, while the three salamanders known from Africa are all close relatives, including the Spanish Newt, *Pleurodeles waltl*. The newts on the Pacific Coast of the United States are more akin to those in Asia. The newts in the Atlantic

drainage, including the Mississippi Valley, are smaller and more like the newts of Europe.

The Great Crested Newt, *Triturus cristatus.* Late in February or early in March the great crested newt, largest of the three newts of England, crawls forth from the bottom of ditches and ponds, from the warm crevices and underside of logs. It has hibernated there, safe from the winter frosts, since October, perhaps briefly poking its head out during a few warm spells in the winter. In April, if it is of breeding age, it will return to the water for courtship and mating.

The female is some six inches long, slightly larger than her mate. The upper parts of both male and female are mottled purplish black to dark brown, sometimes with black spots. The belly varies from bright orange to yellow, with irregular black spots. When full grown the male has a high, notched crest or keel on his back, which is separated from a similar crest in his tail. Viewed from the side, this crest has the appearance of a saw with irregular, badly sharpened teeth. This fleshy keel on the back is absent in the female; her tail is provided with fins, or flattened extensions of the skin, smaller than those of the male.

——How the Crested Newt Breeds. In April as a rule, males and females assemble in ponds or quiet streams. The male becomes excited in his movements and lashes his tail, stirring up the water near the female by his agitated behavior. Finally he deposits a somewhat cone-shaped structure of jelly in front of the female. This contains a packet of sperm, which the female immediately picks up with the lips of her vent. The spermatozoa, or male germ cells, are kept in finger-like pockets in the roof of the female's vent. From there they find their way inside her body where they fertilize the eggs.

The eggs, each enclosed in a flattened ball of jelly, are laid singly. The female usually wraps a leaf about each egg as it is laid, using any sort of water plant to provide this additional protection. A partly transparent, fishlike larva appears about twenty days later; the time required for development depends to some extent upon the temperature of the water. The large-headed larva, with delicate, feather-like gills, eats the tiny animals sharing its pool. Its front legs begin to appear, followed by the hind ones. Finally, by late August, development is complete. The gills are absorbed, and the transparent skin is

replaced by an opaque one more closely resembling that of the parents. The salamander is now ready to leave the water.

The great crested newt spends two or three years on land before returning to the water. It breeds almost immediately upon its return, although it may continue to grow until the end of its fifth year.

The great crested newt is more inclined to remain in the water than either the Smooth Newt, *Triturus vulgaris,* or the Palmated Newt, *Triturus helveticus.* All three may sometimes be found in the same pond. Here they prey upon tadpoles, worms, insect larvae—virtually any small object that moves, attracts their attention. Small boys catch them by tying a worm to a piece of string and dangling it in the water. A small piece of meat, as long as it is agitated, serves equally well as bait.

——How the Crested Newt Defends Itself. The crested newt does not hesitate to prey upon its small relative, the smooth newt, or even upon the young of its own kind. But it is itself protected from the appetite of many larger animals by its skin, which is covered with tiny warts or tubercles (that is why it is sometimes called the warty newt). These are actually tiny glands producing a poisonous substance so disagreeable that it repels even those snakes and other animals for whom most salamanders furnish a favorite food.

The American Spotted Newt, *Triturus viridescens.* The common or spotted newt of the eastern United States is easy prey for the newt hunter. Throughout the spring and summer I have found many of them in the ponds of the Palisades within a few miles of New York City, and farther inland in clear mountain lakes or ponds where the adults often congregate. In ponds filled with leaves or other vegetation they are not so easily seen; but once, by raking the leaves from the water's edge in early spring, I found as many as thirty of them in half an hour. The spotted newt is active throughout the day and so is easier to find than many other salamanders that come out only during the hours of darkness.

The spotted newt is slightly more than half as large as the great crested newt. But its manner of living, its life history, and its feeding habits are much like that of its British relative.

——Courtship Among the Spotted Newts. The male of the spotted newt is larger than the female on the average. (We have

seen that among the crested newts the female is the larger.) During the mating season the tail fins of both male and female become enlarged, but much more so in the male. He also acquires patches of thickened black skin on the inner side of his thighs and the tips of his toes, which he uses to seize the female following courtship.

There is one peculiar aspect to the courtship and breeding behavior of spotted newts. In the fall and occasionally at warm intervals during the winter, dozens of them will gather in the ponds to perform mating antics. This is a false breeding, however, for the female will not deposit her eggs until the spring.

The genuine mating activities follow the spring migration to the water. The newt, having spent from two to three years on land as a red eft, is now ready to breed. There are profound changes in his skin and in other parts of his body that prepare him for breeding and for his return to life in the water. (In some places, on Long Island in New York, for example, the land-dwelling stage may be omitted.)

Courtship begins with the male moving stealthily toward the female. She may dart away, but the male repeats his approach. Glands in his cheeks expel a colorless substance into the water. This increases the female's interest, and she pauses. Thereupon the male becomes agitated and goes through a series of contortions. He rubs the side of his head against the snout of the female. Suddenly he seizes the female, grasping her from above at the shoulder region with his hind limbs. While he holds the female securely, he may sit with her on the bottom of the pool for several hours.

Finally they are ready to complete the mating. The male deposits as many as three disklike gelatinous masses. An oval packet of male germ cells is attached at the upper end of a thin cord that rises from the disk. This packet is picked up by the female and the eggs are fertilized in much the same manner as in the crested newt. The eggs are also deposited in a similar fashion, one at a time, and fastened to leaves or plants in the water. Only a few eggs are deposited each day until a total of two hundred or more have been laid.

——How the Spotted Newt Develops. The eggs hatch within a month, more or less, depending upon how cool the water remains. Usually in May the larvae break the transparent membranes surrounding the eggs and free themselves. They are then about five-eighths of an inch long, light yellowish green in color, with a faint

gray line on either side of the spine. After about two months the larvae are nearly an inch and a half long and ready to lose their gills, as well as the keel on the back and the tail fins.

At first, respiration or "breathing" is carried on through the gills and the skin. As its lungs develop, the larva begins to use them, coming to the surface for air. When the gills are finally absorbed, the newt leaves the water. At this stage its skin is light yellowish, reddish brown or even olive green. But gradually it changes to bright red, with a row of black-bordered vermilion spots on each side of the back. It is now a red eft. Its skin is thickened and rough, no longer suitable for water-breathing. It now breathes solely through its lungs.

On land the eft wanders about in cool, shady places, usually in wooded areas. Sunlight is not entirely shunned, for the eft can stand more heat than can other salamanders. But during dry weather it seeks the seclusion of moist crevices. Following rains, or on occasions when the weather is foggy, it stalks its prey at any hour of the day or night, feeding on mites, spiders, insects, worms, and small snails.

——EFTS VARY IN SIZE. The eft looks for moist places underground as the cold winter months approach. At elevations of four thousand feet in the Adirondacks in New York its active growing season may be short, but in the lowlands from Louisiana to Florida along the Gulf Coast, it is probably active the year 'round. Yet newts from the South are smaller than their northern relatives. Because of these variations and slight differences in color, they are considered to be a race or subspecies of the spotted newt of the North.

Some people grow more rapidly or become taller than others. And this is also true of newts. Again, their size varies from one locale to another. Dr. Sherman C. Bishop measured a number of red efts he captured one August in the woods near Cossayuna Lake in Washington County, New York. He found they could be separated into three groups. Those that he believed to be in their first year on land were about two inches long. Some were a trifle smaller, others larger. Some that he thought were in their second year on land averaged a half-inch longer. Those in the remaining group, about three inches long, were supposedly in their third year on land and ready to return to the lake where they had begun life.

——HOW THE EFT PREPARES TO RETURN TO THE WATER. The newt resumes its water-dwelling existence four years, more or less, after it leaves the egg. Its life cycle is complete: it is now ready to

mate—to start the next generation on its way. Before the eft reaches the water, or often after it arrives, its skin again begins to change color. The bright red skin slowly turns to greenish olive. The roughened skin once more becomes smooth and fit for "breathing" under water, even though the eft continues to use its lungs. Its tail, rounded while on land, now grows fins.

——WHAT THE SPOTTED NEWT FEEDS ON. The return to the water is marked by changes in the spotted newt's food habits. As a water-dwelling salamander it must now find its prey in pools or streams, feeding on small water beetles, caddis fly larvae, leeches, worms, and fairy shrimp, depending largely upon what is most abundant. Dr. W. J. Hamilton of Cornell University has found that newts are efficient destroyers of mosquito larvae. During late March he discovered newts eating the eggs of the Spotted Salamander, *Ambystoma maculatum*. Newts also devour their own discarded skin, a thin transparent cover that is shed at intervals.

Because of their destruction of mosquitoes the spotted newts may be considered beneficial to man. Upon rare occasions they devour small fish, and possibly their eggs; but the damage is not serious. Newts are interesting to study and observe, and few salamanders are so easily kept in captivity.

THE LUNGLESS SALAMANDERS

The majority of the American tailed amphibians belong to the family Plethodontidae, whose name derives from the Greek and means "full of teeth." All members of this family lack lungs, and all possess a groove extending from each nostril to the lip. This structure, the "nasolabial groove," has no apparent use beyond serving to drain water from the nostril. The family is the only one that has succeeded in invading South America. Except for one species of the genus *Hydromantes* that lives in the Alps and on the island of Sardinia, the family is confined to the New World.

Those that live in the United States include the arboreal salamander, which, as its name indicates, lives mostly in trees; and the green salamander, a cliff dweller. The arboreal salamander is found on the Pacific Coast, while the green salamander dwells in the Appalachian regions.

The Arboreal Salamander, *Aneides lugubris.* I saw my first arboreal salamander in a gold mine in California. I was about fourteen years old at the time and with some other boys I had walked up into Millard Canyon below Mount Lowe in the San Gabriel Mountains back of Pasadena. Here there were several abandoned mine shafts that had been dug into the granite walls of the canyon. We had candles and we found a can with which we improvised a lantern. Then we entered what we judged to be the deepest tunnel because it had the largest pile of rocks near the entrance.

Water from small cracks in the jagged roof trickled to the floor of the tunnel where two rivulets of clear water flowed toward the outside. As we moved into the depths of the shaft I was startled to see something wriggle in the water. Directing my makeshift lantern toward the source of the movement, I saw the shiny, dark body of a salamander. Farther back in the mine we found two more.

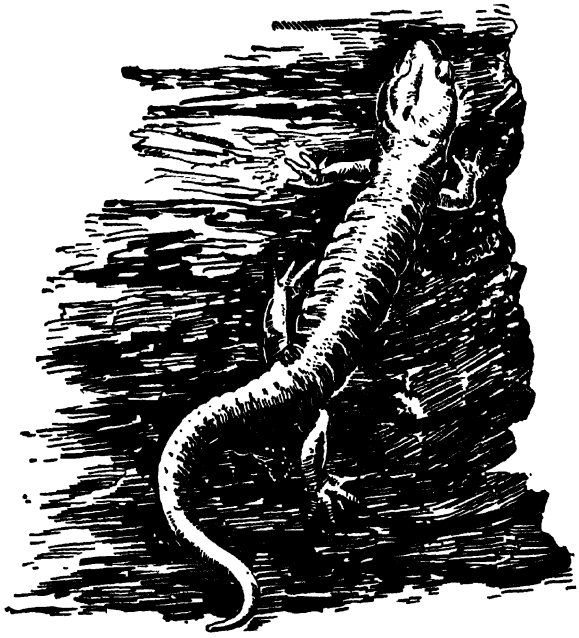
Carrying these with us, we hastened to the exit. Outside in the bright sunshine we examined our captives. They were stout-bodied creatures about six inches long. Their smooth brown skin had a sprinkling of yellow dots along each side of the body. Grooves in the same regions gave the body a ribbed or corrugated appearance. The head broadened noticeably behind the eyes, which were located well forward on the head. One of the salamanders squirmed in my hand, and I felt faint scratches as the teeth from its overhanging upper jaw scraped over my fingers.

I was astonished to learn, some months later, that the animal was called the arboreal salamander. Later on I found others, usually under boards or the bark of wet, decaying logs. On the hill above the Los Angeles River in Elysian Park I discovered two under flat rocks that I had overturned in search of centipedes. Why was an amphibian that lived in such places called the arboreal salamander?—a name implying that it lived in trees. Of the many I had found, not one was in a tree.

Some years later when I was in college I found the answer in a book. More than a hundred of these salamanders had been discovered by workmen cleaning out the rotted wood from the holes of the live oaks on the campus of the University of California at Berkeley. Along with salamanders they had found twelve clutches of eggs. Fortunately, Dr. Loye Miller was on hand while this work was being done. He had

tried many times before to find these salamanders during the dry summer months.

Encouraged by this fortunate disclosure of the animal's breeding habits, Dr. Miller soon learned a great deal more. The arboreal salamander had been described a half century earlier, during the year that gold discoveries brought the "Forty-niners" flocking into California. But little was known about it before Dr. Miller's investigations.



A SALAMANDER THAT LIVES IN TREES

The arboreal salamander, a six-inch creature that has no lungs but gets its oxygen through its skin and the lining of its mouth, spends most of its life in trees. A fine climber, this salamander is able to curl its tail about tree limbs. It deposits its eggs in tree cavities, sometimes as high as twenty feet above the ground.

——How the Arboreal Salamander Develops. The drama of the arboreal salamander's early development can be observed through the transparent envelope that covers the egg. Limb buds, later to become legs, appear first in front and then in back. A few days later the gills, which will disappear even before the young animal has

hatched, begin to grow. These are flattened and branched, the blood coursing through them in tiny vessels as the heart beats. They continue to grow and expand over the embryo, which is curled around the yolk, its food supply. Several days later the transient gills begin to disappear and are finally lost as the tiny animal assumes the adult shape, eventually becoming a fully formed salamander within the moist egg membranes.

Mr. Miller found that though the arboreal salamander sometimes lays its eggs on the ground, it more often deposits them in cavities of oaks—occasionally as high as twenty feet above the ground. The eggs are fairly large, sometimes three-eighths of an inch in diameter, and each is attached to the roof of the cavity by a slender, gelatinous thread. From twelve to nineteen are laid, and usually an adult is found coiled around them. Eggs are deposited during the months of July and August, when the ground in California is baked and dry. Perhaps the animal locates its "nest" in oak trees because the crevices have a certain amount of moisture. It has been suggested that the coiling of the mother's moist body around the eggs keeps them from becoming too dry to develop.

Evidently the mother remains in close contact with the suspended capsules. Perhaps she guards them from raids—even from others of her kind. Adult individuals brought into the laboratory sometimes devour their own eggs.

When the inch-long salamander hatches after two months or so, its body contains a small store of food left over from the yolk. On coming out of the egg, the young cluster together, which helps to prevent them from becoming too dry. Soon the fall rains of the Pacific Coast bring the moisture that allows them to leave their "nest." They descend to the ground where they may feed throughout much of the winter before next summer's drought again drives them to shelter—perhaps in the trees, or to such wet places as the old mine tunnel where I first saw them.

However, there can be little doubt that arboreal salamanders spend a good deal of their life in trees. Their toes are somewhat flattened and broader at the tips, suggesting that they may be used like the adhesive pads on such climbers as the Tree Frogs, *Hyla*.

Also, the arboreal salamander can curl its tail around a limb, the way an opossum does, to hold on as a precaution when climbing. The tail of other land-dwelling salamanders is easily fractured, which

sometimes distracts the attention of an enemy from the salamander itself. But the tail of the arboreal salamander is not easily broken. It is usually curled in a spiral to one side while the creature is at rest.

——How the Arboreal Salamander Gets Its Food. The arboreal salamander forages at night, possibly on trees as well as the ground. It eats insects, including ants and various kinds of beetles. Dr. Miller has found pieces of wood and fungus in the waste matter of animals recently captured. He believes that fungus growing inside the cavities of the oaks inhabited is occasionally devoured during the summer months, when the outside air is too dry for the salamander to leave its home.

The arboreal salamander, like all members of the Plethodontidae family, has no lungs. It breathes through its skin and may besides draw some air into its mouth by throat movements. Dr. Miller has heard two individuals utter a mouselike squeak, possibly caused by the expulsion of air from the throat.

The animal's teeth, easily felt by rubbing a finger over its snout, are dagger-shaped and extraordinarily large for its size. Adults sometimes bite at a stick or a finger thrust in front of them. This show of fight may be of importance to females guarding their eggs.

——Relatives of the Arboreal Salamander. The arboreal salamander has few close relatives. There are two on the Pacific Coast of the United States, one in the Sacramento Mountains of New Mexico, and a fourth in the Appalachians between West Virginia and Georgia. The last of these is known as the Green Salamander, *Aneides aeneus*. It is one of the most beautifully colored of all salamanders.

The habits and life histories of the green and the arboreal salamanders are very much alike, though their ranges are two thousand miles apart. Each has acquired the coloration and form that fit it for survival under the conditions where it now lives. Yet their common mode of existence, with few changes, has evidently been handed down from some ancient common ancestor.

Professor E. D. Cope found one of these salamanders in Nikajack Cave in Tennessee and named it *aeneus*, meaning "bronzed," because of the blotches of greenish yellow that adorn its back and sides. Its coloring blends with that of the lichens that grow on cliffs and trees and may protect it from the eyes of its enemies.

For it seems to be essentially a cliff dweller, whether the cliff be of limestone, sandstone, quartzite, or granite. A green salamander has

turned up in a woodpile in North Carolina, and others have been found beneath the loose bark of dead trees. The eggs were first found in a cavity of a fallen limb of the water-oak by Mr. Clifford H. Pope. More recently the green salamander has been found breeding in the horizontal crevices of granite cliffs in North Carolina.

The female green salamander selects damp but not wet places where the temperature is about 65° Fahrenheit, to lay her eggs. She lays as many as twenty-three, each suspended by strands of mucus from the top of the crevice. The mother is always on hand and often lies coiled around the clutch. The young hatch in something over two months, and on two occasions the parent has been found with her recently hatched young.

The most impressive aspect of the life of salamanders and related creatures is their adaptability—their size varies from two inches to five feet; some have gills, some have lungs, some breathe through the skin; some live in the water, some on land, some underground, some in trees. This adaptability is what we would expect from a group that has maintained itself for 340 million years.

The Frogs and the Toads —Amphibians without Tails

FROGS are so common and so widely distributed that most of us make their acquaintance at an early age. If they were rare creatures, or confined to some distant outpost, we might well look upon them as marvels of nature. In many respects that is just what they are.

The salamander waddles along slowly, rather crudely, twisting its body from side to side as its feet move outward and forward. The more efficient toad hops along much more rapidly. The frog, in one

swift leap, dives from the shore on the approach of an enemy. Such methods of traveling, or of eluding capture, may be the chief reasons for the survival of the tailless amphibians. The name of their order Salientia, means "leaping animals." This flourishing group can scarcely be called defeated. Frogs have not achieved the emancipated state attained by birds or mammals—or even reptiles. Still, there is no reason to believe that the group is waning.

HOW TOADS DIFFER FROM FROGS

The name "toad" is commonly used to refer to any of several closely related animals belonging to the genus *Bufo*. Toads breed in water but spend much of their time on land, sometimes miles from permanent pools. Their skin is usually rough. It is moist, but not slippery with mucus.

But there are other tailless amphibians that seldom stray far from water. They forage along creek or river banks, in pools, marshes, or sloughs. Their skin is commonly smooth, well lubricated with mucus, and feels wet to the touch. Such animals are known as "frogs" or as "true frogs" and belong to the genus *Rana*. This Latin name has been retained unchanged in Spanish, so that in Spain and Latin America a frog is still called a *rana*. The toad is called a *sapo*, however, the original Latin name *Bufo* having been corrupted in the course of time.

In contrast to the group names *Bufo* and *Rana* for several closely related kinds of animals, the popular names "toad" and "frog" are used indiscriminately. Members of the genus *Hyla*, which often live in trees, are interchangeably called "tree frogs" or "tree toads." Some pointed-nosed burrowers that live in the southeastern portion of the United States are called either "narrow-mouthed frogs" or "narrow-mouthed toads." The Surinam Toad, *Pipa pipa*, of South America is always called a "toad" despite the fact that it is strictly a water-dwelling animal and hence more like a true frog.

Common or vernacular names, therefore, are largely a matter of convention. They are often merely the designations coined by travelers or writers who have felt the need for some simple way of talking about a particular animal. But all tailless amphibians, when spoken of collectively—as the whole assemblage—are "frogs." The Midwife Toad, *Alytes obstetricans*, of Europe, and the British Toad,

Bufo calamita, popularly called the "natterjack," for example, might be included in a list of the "frogs of Europe."

TOADS

Toads are among the most interesting and most familiar amphibians. But familiarity does not always result in understanding, and folklore notions about toads tell us more about people than about toads. Hence the familiar myths that toads produce warts, and that it "rains" toads. As we shall see later on, scientific study has distinguished between truth and fancy in describing the life of the toad.

The toads form one of the dominant families (Bufonidae) among the tailless amphibians. According to some authorities, the toad family has as many as seven subfamilies. The family Bufonidae includes many common species as well as some with the most bizarre specializations. The Mexican Burrowing Toad, *Rhinophrynus dorsalis,* for example, is a sharp-nosed, pink-and-brown species that feeds largely on termites. Then there is the so-called "robber frog" of the genus *Leptodactylus* (widespread in the Americas). Unlike most toads, the "robber frog" has teeth, and many authors prefer to separate this and some related genera as a distant family, the Leptodactylidae.

Toads in the scientific sense (the species of *Bufo*) live in most parts of the world and are about as well known as any amphibians. Formerly they were absent from Australia and the islands of New Guinea, Madagascar and a few others; but one kind of toad or another has appeared in many of these areas—brought there by man in his efforts to control insect pests. There are three kinds in Europe, two of which are found in England, and well over a dozen in the United States. Toads live in mountains, valleys, or plains, from Alaska to the tropics. They live in forests or in deserts, almost any place where there is a warm summer and sufficient fresh water to enable them to breed.

HOW TOADS BREED

The toad does not need more than a temporary, often very shallow pool, but its eggs must be laid in water. In temperate regions the breeding season usually coincides with the spring rains. The first April downpour brings out the American Toad, *Bufo terrestris americanus,* in great numbers. Each has spent the winter in a secluded

spot underground, often some distance from water. After dark the males make their way to a suitable pool, frequently crossing ditches or other water to reach the breeding site.



A TOAD THAT KNOWS ITS WAY HOME

The American toad is famous for its homing abilities. It has been known to return to its breeding site after being carried a mile away. Scientists who have studied this toad believe it is guided by the droning calls of its fellows in the "home" breeding pond.

We do not know exactly why the male toad finds one place attractive and another unattractive. But nearly always he calls from a place that is going to be suitable for the female to deposit her eggs. As a rule, the pond or stream selected will not dry up before the young can hop away. Occasionally a toad makes a mistake, but it is evident from field observation that the site chosen usually comes close to the ideal for breeding purposes. Sometimes newly created man-made

ponds are used, while other times a previously satisfactory pond may be abandoned. Thus it is obvious that the toad's choice depends upon existing circumstances.

HOW THE TOAD ATTRACTS A MATE

There is no real courtship among the tailless amphibians. However, the voice plays an important part in their mating. The first male toad to reach an acceptable pool begins to call. He inflates a balloon-like extension of his throat by expelling air from his lungs. The mouth and nostrils are kept tightly closed, for the toad does not use his lungs for breathing while he is calling. Air is driven back and forth over the vocal cords, between the lungs and the mouth. The whole animal vibrates as the sound produced is magnified in the distended throat, or vocal pouch, which serves as a resonator.

The melodious drone of the male American toad carries some distance and attracts the female. He seizes the first female to appear, climbs on her back, and grasps her firmly with his fingers. During the breeding season his thumb and inner finger are provided with dark horny growths—the nuptial pads. These enable him to hold on when other suitors appear. They may attempt to dispossess him, but ordinarily the first toad to seize the female is the one that remains to fertilize her eggs.

HOW THE EGG DEVELOPS

The American toad, like most others, lays as many as eight thousand eggs in two long strings of jelly. The female expels the eggs as she moves about, and the male on her back fertilizes them as they reach the water. The eggs hatch within three days if the water is warm, but it may take nearly two weeks for them to hatch if it is cold. The tadpoles, like those of most other toads, are black.

Gills appear on the outside early in the development of the tadpole. But they disappear when a fold from the head grows back to cover them. Water is drawn into the mouth, passes over the gills inside the head, and out through an opening, called the spiracle, at one side.

A black horny beak surrounded by rows of horny combs at the front serves as a mouth. During the next two months the tadpole feeds frequently—mainly on vegetation which it rasps from plants growing in

the water. Though the tadpole is essentially a vegetarian, it also relishes dead animals, including other tadpoles.

As to growth, hind limbs appear first, followed by front limbs. Its tail becomes progressively shorter at the same time that its lungs are developing. It never gets teeth, but bony jaws form, and a more ordinary mouth replaces the horny beak and combs. The fully formed toad is now ready to move to land, even though its tail may still not be completely absorbed.

The toadlet remains near the water for a long time. It hides by day and comes out to feed at night if the weather is dry and warm. It devours small insects or their larvae, centipedes, spiders—in fact almost any small animal that moves. The toad misses any prey which, though still alive, does not move.

Taking advantage of rains and traveling at night in order to conserve the water that would be lost through evaporation, the small toads scatter out from the breeding site. Some may be killed accidentally or devoured by enemies. Eventually each survivor finds a suitable shelter, often in a garden or a cultivated field. Feeding voraciously, mostly on insects, the toad is probably mature and ready to breed by the beginning of its third year. Thereafter its growth slowly tapers to a halt. Males rarely exceed three and a quarter inches in length; females may be an inch longer.

The Carolina Toad, *Bufo terrestris terrestris.* The American toad ranges throughout the eastern United States and southeastern Canada. In the extreme Southeast it gives way to the Carolina Toad, *Bufo terrestris terrestris.* This one is similar to its northern relative, but has a pair of knoblike projections above and behind its eyes. I have studied the habits of the Carolina toad at the Archbold Biological Station in Florida, where the species was abundant. On the basis of the samples secured there, I estimated that nearly eight hundred toads of this species live in the immediate vicinity of the station.

——THE CAROLINA TOAD'S HOMING ABILITY. The northern representative breeds from early in April through July. In central Florida the season is much longer, starting in March. I found the Carolina toad breeding throughout the summer, as late as mid-September. Following summer showers I heard these toads calling in great numbers from pools just outside my quarters. I kept a record of the number I could find each night, and if there had been no rain

during the day, few toads were abroad. The heavier the rainfall, the more toads I found.

One night after five inches of rain had fallen, I collected nearly two hundred toads in an hour's time. I marked these and many others so that I could recognize them when I saw them again. Then I carried them away in different directions from the pool near the laboratory where I had captured most of them. I freed forty-three toads a mile away, and later found eight of them quite near the laboratory. I had carried them across a cleared area free of toads, and so it is doubtful that any of them had ever been in the area. How did they find their way home?

I could not answer this question for certain, but by studying all the facts I could gather, I concluded that these toads had probably been guided back to the home site by the chorus of voices that still echoed from the breeding pond. Many others in addition to the ones I found must have returned home, for it would not have been possible for me to find all of them.

I also discovered while working at the laboratory that toads apparently come out at intervals to feed for a while and then disappear again, even though the weather may be suitable for them to remain abroad. Presumably they retire underground.

One night I found a toad sitting on the sidewalk near a building at the Archbold Laboratory. I picked it up and examined it, noticing that it had two toes grown together on the right hind foot. Because I was nearing the end of my stay, I merely tossed the toad a few feet back from the walk.

The following night, as I made my rounds, I noticed a toad sitting in the same place as the one I had seen and examined the night before. I captured it and found it to be the same one with the toe deformity. During the next two weeks I encountered this deformed toad in almost the same spot night after night. Only once did I fail to see it.

Here was a toad that came at the same hour every night to the same spot on the sidewalk. It was not there earlier in the day, or I would have seen it. By day it was gone, but night after night it reappeared. How long it continued to come to this feeding station I can only guess because I had to leave after two weeks' observation.

The Oak Toad, *Bufo quercicus.* In this same region of Florida there is another, much smaller member of the group—the oak

toad. It is rarely longer than an inch and a quarter. The shrill call of this tiny toad is well-nigh deafening. When a chorus was close by, I seemed actually to feel excessive pressure on my eardrums.

The breeding habits of this smaller toad are not unlike those of its larger relative. However, the oak toad deposits its eggs in small rods of jelly, from two to six in each rod.

The Desert Toad, *Bufo punctatus.* In the arid Southwest of the United States there is a toad of medium size that deposits its eggs singly rather than in the characteristic string. This is the desert toad, whose call is a melodious trill resembling the noise produced by the common cricket. The desert toad ordinarily inhabits rocky areas and its body is flattened. This is useful when the toad is seeking shelter in crevices.

It does not always secrete itself among rocks, however. At the bottom of the Grand Canyon in Arizona I once overturned a wooden keg that had been placed under a trickle of water. Over a dozen toads were packed solidly beneath its wet bottom. Outside, the ground was dry, and I had seen no toads. On other occasions I saw them appear in considerable numbers immediately after a summer thundershower.

MYTHS ABOUT TOADS

The appearance of toads under such conditions has given rise to a widespread belief that it "rains toads." Indeed it is not impossible to gain the impression that they have come from "out of the nowhere, into the here." But certain it is that they have not come from the sky! Doubtless the presence of moisture has merely given them the signal to come out of the crevices or burrows where they have hidden in order to avoid the drying effects of the desert air.

The belief that "toads cause warts" is another common superstition. This ridiculous notion apparently results from the assumption that the "warts" on the toad's skin are contagious. As a child I often caught and handled the toads that appeared in irrigation ditches on our ranch in Colorado. The workmen and visiting neighbors would admonish me: "You'd better not play with those. You'll get warts!" Ignoring their not-so-sage advice, I continued to handle toads, and my repeated experiments never produced the dire effects my elders predicted. I am sure that my parents never believed the superstition and perhaps they relieved my worries.

It was not until later that I learned that the "warts" on toads are actually small glands that produce a poison. If there are no cuts or abrasions on your hands, you can hold most toads without danger. However, if the poison enters a cut, or if it gets into the eye, it can cause an intense irritation.

POISON GLANDS FOR DEFENSE

Such glands in the toad's skin are scattered over the upper surface, one over each shoulder usually being much larger than the others. The poison produced by these "warts" discourages many attackers. Dogs sometimes make the mistake of believing the toad to be a harmless plaything. However, when seized the toad proves to be a bitter mouthful. The dog froths at the mouth and the way he behaves makes it clear that the toad's poison is effective.

Far more severe effects result from the poisons of some of the larger species of toads. The Colorado River Toad, *Bufo alvarius*, living in the desert regions near the mouth of the Colorado River, occasionally reaches a body length of seven inches. Its greenish gray skin is smooth, with few glands or "warts" on it. This toad has the usual enlarged gland over each shoulder, in addition to some on the arms and legs. Dogs that attacked these giants of the genus *Bufo* have been known to die from the effects of the poison. We need further investigation, since it is not certain whether the deadly substance is swallowed or whether it enters the dog's blood stream through the thin skin lining the mouth. It has even been suggested that vapor from the poison is inhaled or drawn into the lungs of the unsuspecting dog.

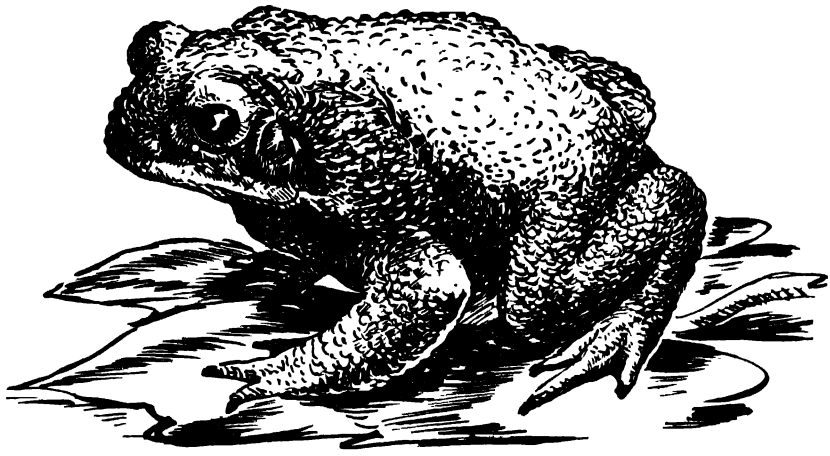
TOADS AS PEST EXTERMINATORS

A toad with such a deadly way of protecting itself might be considered dangerous to have around. This is not the case, however, for if the toad is not mistreated, it can be picked up and handled without causing its captor any discomfort. While I was working in Arizona one summer, my family and I stayed in a house that was inhabited by scorpions. There were not a great many, but we had found one or two every night. The ordinary scorpion has a sting little worse than a bee's, but these were the kind that sometimes produce severe symptoms.

In an effort to reduce the number of scorpions, I kept two Colorado

River toads on the front porch, where the scorpions had been most often encountered. I provided water for the toads in a pan, where they sat during the day, coming out at night to hop about the concrete floor of their screened enclosure. While I was away on a trip the pan became dry and I returned too late to replenish the water. With no moisture to replace that lost through the skin, the toads were nearly dead when I arrived. One toad rallied when I put it in water, but the other was so dried out that it could not be revived. When I examined it to see what it had been eating, I found five scorpions and two crickets in its stomach. Evidently, therefore, the poor creature had been doing the extermination job I had set for it.

The Neotropical Toad, *Bufo marinus.* The Colorado River toad is exceeded in size by the neotropical toad, one of the most abundant and widely distributed toads in the American tropics. This Goliath



A GIANT AMONG TOADS

The neotropical toad is the colossus among the tailless amphibians in the Americas. Large females are sometimes as much as nine inches long and six inches across with the limbs folded. The giant toad has been introduced throughout the tropics to control insects infesting sugar cane plantations.

among tailless amphibians in the Western Hemisphere reaches its greatest size in northern South America. A female with a body length of nine inches was taken in British Guiana by Mr. Robert Snedigar. The specimen, the largest one known, is in the collection of the American Museum of Natural History.

This great toad has a range extending southward from southern Texas through the lowlands of Mexico to Brazil. Its parotoid glands, those over the shoulder, are enormous. If the toad is irritated, a milky secretion oozes from the pores of the gland. After Dr. Albert P. Blair liberated some of these toads in a pond in southern Texas, a turtle appeared and seized one of them from below. The toad, with its lungs inflated, could not easily be pulled under. As the turtle continued its attack, Blair saw the poison appear on the surface of the gland, and the turtle abruptly dropped its intended prey and departed.

The success of the neotropical toad, as indicated by its abundance, can be attributed in part to the protection the poison glands afford. The majority of the frogs, *Rana,* are not so well equipped. The Pickerel Frog, *Rana palustrus,* is an exception, with a skin so well lubricated with poison that other amphibians placed in the same container with it are likely to succumb. Most frogs avoid their enemies by means of a sudden leap into the water.

THE TRUE FROGS

The biography and habits of the common frogs *(Rana)* are fundamentally pretty much the same as those of the toad. The male frog of each species has a distinctive call, no two kinds being identical. In each case it serves to entice the female of its kind to the breeding pool. Here the eggs are fertilized in somewhat the same manner as those of the toad. However, frogs do not lay their eggs in long strings. Generally they deposit their eggs in a single clump and anchor them to plants growing in the water.

Permanent pools or lakes are usually preferred. The size of the egg cluster and the place selected for laying the eggs vary from species to species. Some kinds can endure low temperatures better than others. From the northeastern United States westward throughout most of Canada, the Wood Frog, *Rana sylvatica,* is among the first amphibians to appear during the spring. This is one of the smaller frogs, little more than three inches in length. I have observed wood frogs breeding in March when ice was still in the ponds, and the water was only a few degrees above freezing. Such frogs lay relatively small clumps of eggs, a thousand or so, usually a few inches below the surface.

The family Ranidae includes our common bullfrog. It is primarily an Old World group, with the greatest number of species in Africa. In the New World, as well as in Australia, there is but a single genus, *Rana*. Several species live in Canada, the United States, and Mexico, but only one has reached South America. There are numerous genera in Africa, especially in the rain-forests. The famed "Hairy Frog," *Astylosternus robustus,* is a ranid, the male of which has hairlike extensions from the skin on the thighs and flanks. Apparently these do the work of gills, and compensate for the greatly reduced lungs of this frog. The largest tailless amphibian now living is a gigantic ranid in Africa.

The American Bullfrog, *Rana catesbeiana.* In contrast to smaller kinds, the American bullfrog does not ordinarily deposit its eggs until much later in the year, in June or July in the northern part of the United States. By this late date the surface of the water may have reached 70° Fahrenheit. In the South breeding occurs much earlier. The huge egg-mass contains as many as twenty thousand eggs—according to Dr. A. H. Wright, one of the few who has ever undertaken the task of counting them. The eggs spread out in a film on the surface of the water. Exceptionally large masses cover five square feet.

——THE SIZE OF BULLFROGS. Bullfrogs were originally native to eastern North America, from Canada southward to the Coatzacoalcos River at the Isthmus of Tehuantepec in Mexico. Because the legs of this large frog are in considerable demand as food, the bullfrog has been widely introduced throughout the western part of the United States as well as into other parts of the world. In the South the female, the larger of the two sexes, attains a body length of eight inches. In the North seven inches is closer to the maximum, and such sizes are the exception rather than the rule.

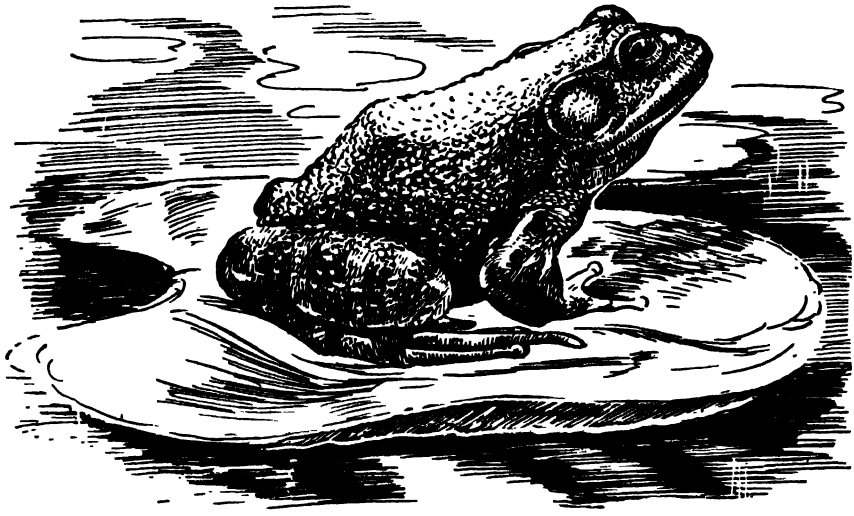
The bullfrog is the largest tailless amphibian in the United States. Elsewhere it is exceeded in size, notably by the Giant Frog, *Rana (Conrua) goliath,* of the Cameroons and the Gabon region of west Africa. The giant frog may measure as much as a foot or more in length, and weigh as much as a large domestic cat. It lives in deep forest streams, where natives are seldom able to capture it except during the dry season when the water is low.

Bullfrogs require permanent pools partly because the tadpole may take as long as three years to transform. Legs rarely develop during the

first summer, but under ideal conditions they appear early during the second year. The astonishingly large tadpole may be half a foot long before the tail begins to be absorbed. However, when ready to depart from the water, minus its tail, and no longer a tadpole, the animal measures slightly more than two inches in length.

——WHAT THE BULLFROG FEEDS ON. The bullfrog spends two to three years on land before it reaches adult size. The younger frogs depend largely upon insects for food, but almost any animals small enough to be eaten fall prey to the adult. In many ponds crayfishes form a large proportion of the frog's diet. Presumably the frog captures these bottom-dwelling crustaceans while under the water. On land the bullfrog overpowers and eats salamanders, toads, frogs, small turtles, snakes, mice, and even birds.

——THE BULLFROG'S ENEMIES. On the other hand, a number of other animals prey upon the bullfrog. As a tadpole it is attacked by such insects as the giant water bug. This water-dwelling insect uses a tubular, needle-like snout to extract the body fluids of the tadpole. Fish undoubtedly eat the eggs and larvae, as well as the younger



THE AMERICAN BULLFROG AND ITS ENEMIES

The American Bullfrog is the largest tailless amphibian in the United States. The female, larger than her mate, reaches about eight inches in length. She lays about twenty thousand eggs at a time—a fortunate provision against the frog's many enemies. A particularly dangerous foe to the tadpole is the giant water bug, equipped with a needle-like snout to extract body fluids from its victim.

frogs. We may assume that the tadpole is not spurned by birds that normally eat fish. Large bullfrogs may be cannibalistic; they not infrequently attack and devour smaller frogs of their own kind.

Man has become one of the bullfrog's principal enemies. Because these valuable amphibians were in danger of extermination, they are now protected in this country in some states. During a single year, however, nearly three-quarters of a million pounds of frogs' legs were marketed in Louisiana alone. It is doubtful whether all of these were from the bullfrog. Other large frogs, especially the Southern Bullfrog, *Rana grylio,* may have been included in the catch.

OTHER FROGS

Frogs live in all continents, although they are far more abundant in the northern half of the world. Nearly twenty kinds are found in the United States alone, and there are half a dozen additional species in Mexico. Only one of these ranges into South America, probably because this continent was cut off from North America at the time that frogs were first becoming numerous.

The Leopard Frog, *Rana pipiens,* a spotted species, as implied by its common name, is the most widely distributed of any species in North America. It covers the area from coast to coast and ranges southward from Canada to Panama. I have found it in the Pine Barrens of New Jersey, in irrigation ditches in Colorado, and in the streams of California and Arizona. With Dr. A. F. Carr, Jr., I collected specimens near the edge of the cloud forest on Cerro Uyuca in Honduras at an elevation of five thousand feet, and we found it at much lower levels near the margins of Lake Yojoa in the same country. In Costa Rica the leopard frog has been seen in the meadows on the slopes of the great Irazú volcano.

Where there is enough water, leopard frogs manage to live even in deserts. We found a fair-sized population around an isolated spring coming out of a limestone mountain in the middle of the desert in the Mexican state of Coahuila. This group, cut off from others by the intervening deserts, included some specimens with spots, and others that lacked them completely. After capturing thirty of them, however, we found a nearly complete gradation from only a few spots on some creatures to many spots on others.

HOW NATURAL SELECTION WORKS

This variation, or the marked differences that exist between individual animals, is both a source of confusion to the amateur and a source of interest and study to the professional biologist. Changes in climatic conditions over long periods of time may give one individual an advantage over another. Thus, a prolonged period of drought will cause the death of many individual frogs that are less able to resist dry conditions. Others in the same population may, through the accident of inheriting suitable traits, be better able to withstand long periods of dry weather.

In the long run, therefore, the animals that survive will be the ones that live long enough to breed. They will pass on their characteristics to some of their offspring, which thus stand a better chance of survival. Members of the population with unfavorable characteristics are "weeded out," so to speak. During the course of many generations changes will result—changes that enable the surviving frogs to live under increasingly dry conditions in their surroundings. This weeding out of the unfit, coupled with the survival of individuals better adapted for life in the region in which they live, is known as *natural selection.*

SPECIALIZATION AMONG FROGS

Similar processes have brought about a great many changes in the frog's pattern of living. Very often these changes have affected the frog's breeding habits or its life cycle. Through the changes resulting from natural selection, some frogs have managed to overcome the handicap that makes it impossible for any but the more specialized kinds to breed on land. Eggs laid in water are at the mercy of all sorts of hazards; ponds may become dry, fish or other amphibians may eat the eggs. Some kinds of insects deposit their eggs inside those of amphibians, and the grubs that hatch devour the yolk.

There are advantages to be gained, therefore, by depositing eggs where they are not exposed to such raids. One of the tree frogs of Mexico deposits its eggs in the moisture-catching leaves of an air plant that grows on the trunks or limbs of trees. The tadpole manages to move about in somewhat the same fashion as a worm, feeding on the food available on the wet surface of the leaves of the air plant. It

gradually acquires the legs and lungs of the adult without ever going near a pool. Hence this frog is able to live in regions where there are no ponds or streams.

THE WATER TOADS

The water toads, with only four genera and a handful of species living in Europe, Asia, and the Philippines, make up a family of little importance. The one exception in this family (Discoglossidae) is the midwife toad, so called because the male takes care of the newly laid eggs. True, several distantly related amphibians provide parental care, but few are quite so well known as the midwife toad of Europe.

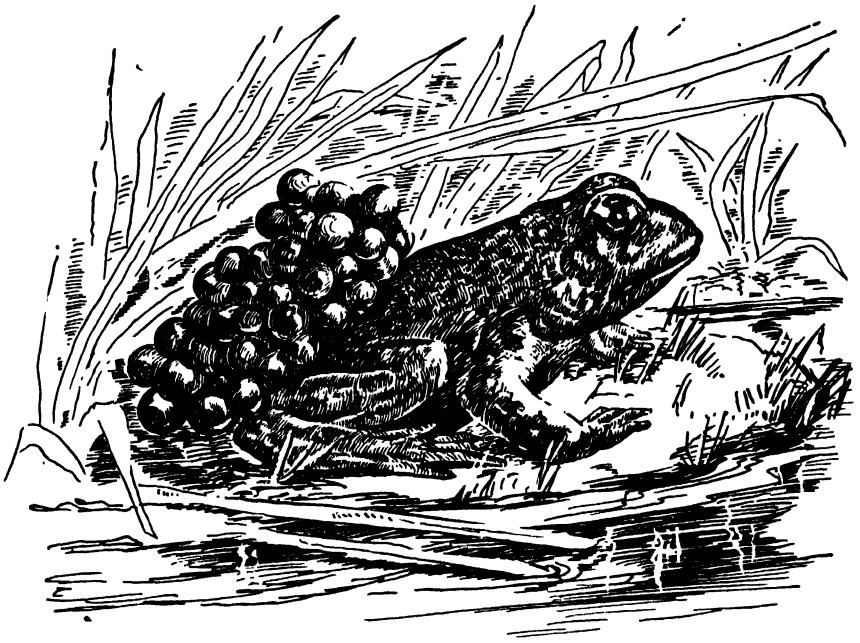
The Midwife Toad, *Alytes obstetricans.* Instead of resorting to the water to breed, the male calls from an entrance to a hole, or burrow, made by himself or appropriated from a rodent. His call attracts the mute female, and several males may gather about her. One male, competing with others, finally grasps the female around her waist.

This embrace may be continued for nearly half an hour while the male strokes the region surrounding the vent. Finally the female extends her hind limbs, which together with the bent hind legs of the male, form a receptacle for the eggs. She expels them in two strings, with several dozen in a set. Each egg is rather large, as much as three-eighths of an inch in diameter. After these eggs have been delivered, the male shifts his body forward, and clasps the female's head as he fertilizes the eggs.

After a pause, he thrusts one leg and then the other through the mass of eggs. When found carrying the eggs with him, the male looks as though the eggs had been wound around his limbs. Meanwhile, the female, her work completed, goes her way, while the male departs with his precious load and returns to his burrow. From time to time during the following nights he comes out to feed, with the eggs still attached to his limbs. Moisture from the dew is absorbed by the eggs on such occasions. The toad may even enter the water carrying his encapsuled offspring with him.

After twenty days or more the larvae within the eggs are well advanced in their development. They have been nourished by the large yolk and the external gills have already disappeared before the male parent carries his load to some pool or stream. This time when they

are dipped in the water the larvae burst the soft, gelatinous coverings and take up life in the water. Thus the eggs as well as the tadpoles in their early stages have been protected from enemies, thanks to the male parent's carrying them with him into his burrow. He has also kept the eggs moist through his efforts.



THE MIDWIFE TOAD—A MODEL FATHER

The male midwife toad becomes attached, literally, to the eggs of his mate. After the female lays her eggs, her mate fertilizes them and then thrusts his legs through the mass of eggs. He carries them around with him, while the female goes unconcernedly on her way. For some three weeks the male takes care of the eggs, keeping them attached to his body all the time. Thus they are kept moist and also protected from enemies until they finally hatch into larvae.

FROGS WITH BUILT-IN NURSERIES

Some tropical frogs have other ways of carrying their eggs. For example, the parent may carry the eggs in a single mass on its back. The South American Frog, *Rhinoderma darwini* (family Rhinodermatidae)—named for Darwin, the naturalist who discovered it while he was on his famed voyage in the *Beagle*—carries the developing eggs in its vocal pouch. Presumably the male picks up from five to fifteen

eggs after they have been laid and fertilized. But he does not swallow the eggs. Instead, they pass through a small slit on each side of his tongue to reach his vocal pouch. The parent carries the eggs in this internal nursery until the fully formed young hatch and depart by way of his mouth.

Some tropical forest frogs, *Phyllobates* and *Dendrobates* (family Dendrobatidae), carry their tadpoles on their back. Dr. Charles M. Breder observed them doing this in Panama. Forest frogs feed during the daytime, moving about constantly in pursuit of their insect prey. Near his camp at Yavisa, Dr. Breder collected a male transporting tadpoles, which were arranged in alternate directions, packed on his back like sardines in a can. The male carries these larvae to pools or to streams where they are able to find their own food.

The Marsupial Frog, *Gastrotheca* (family Hylidae), of South America, has a somewhat more elaborate method of caring for the developing young. The female of this tree frog hides the eggs completely in a pocket on her back. When the young are fully formed, the eggs hatch while still in the purselike pocket. Shortly thereafter the tiny frogs leave the parental shelter through a slit at the rear of the pouch.

THE TONGUELESS TOADS

Many land-dwelling amphibians use their tongues to snare their prey and draw it into the mouth. But frogs that feed under water find little use for either their tongue or eyelids, and these have been lost by most members of the group (family Pipidae). The family consists of only four genera—three in Africa and one, the amazing Surinam Toad and its relatives, in South America.

Frogs belonging to other families have arrived at ways of caring for their young, including the "built-in nurseries" just mentioned. But the Surinam toad has evolved a truly unique method of carrying its eggs. The creature has so many other highly specialized traits that it deserves our close attention.

The Surinam Toad, *Pipa pipa.* Few amphibians are as famous as the Surinam toad, which carries its eggs in individual chambers in the skin of its back. In this instance, as in the case of the marsupial frog, it is the female that carries the eggs. When she is about to lay them, the

female extends from her vent a long, tubular structure called an ovipositor. This is carried forward on her back by the male, who presses on it as the eggs come out one by one. The eggs stick to the skin where each gradually sinks into a separate pocket that forms to receive it. Each of these chambers is covered by a lid apparently developed from portions of the egg capsules. Some weeks later tiny replicas of the adults appear, having gone through all the larval stages sealed in the cavities of their mother's back.

——THE REMARKABLE QUALITIES OF THE SURINAM TOAD. The Surinam toad is a remarkable creature in many other respects. Its entire body is flattened, especially the triangular head. Its eyes, which are extraordinarily small, are situated on the upper surface behind its truncate snout. ("Truncate" means square or even, as if cut off.) There are odd, fleshy projections at the angle of its tongueless mouth. Each of its fingers has a four-pointed, starlike tip. Its hind toes are very long and connected with webs to form broad paddles that propel the animal when it swims, which it does with amazing speed. The Surinam toad probably never leaves the water of its own accord. On land it is clumsy in its movements and nearly helpless.

The animal is so unbelievably different from other tailless amphibians that when Mr. C. B. Perkins placed one on exhibition in the San Diego Zoological Garden, he had person after person come to his office to tell him that "the Surinam toad out there is upside down!"

The creature sits on the bottom with its long fingers spread out on either side of its mouth. Food detectors are apparently located in its starlike finger tips. When they touch some appetizing prey, the toad lurches forward with its mouth open and engulfs it.

Mr. Robert Snedigar told me how he had watched the Surinam toad feed in the quiet pools where he found it near the Essequibo River in British Guiana. A small muscular flap that hangs down over its lower jaw from the snout is kept constantly in motion. The resemblance of this flap to a squirming worm apparently is sufficiently deceptive to entice within reach the armored catfishes that live in the same pools. Snedigar saw the fish approach the "bait," coming in contact with the tips of the fingers as it did so. This was the signal for the toad to lunge, engulfing the head of the fish in its wide mouth.

Curious to see what else the toads might have eaten, Snedigar and I examined the stomach contents of the preserved specimens he had sent to the museum. The examination confirmed his description, for

all we found were the partly digested remains of the armored catfishes. It probably takes other food on occasion, to judge by observations of Surinam toads kept in an aquarium. Nonetheless the curious structure of the fingers, coupled with the angling device, suggests an extreme specialization for a diet made up largely of fish.

Few amphibians are quite so restricted to water as the Surinam toad. However, another member of the same family, the African Clawed Toad, *Xenopus laevis,* seldom ventures onto land. This African relative is not nearly so bizarre in appearance, but it is unique among amphibians in having horny, rather lizard-like claws at the ends of its toes.

FROG HABITS AND HABITATS

The tailless amphibians tend to specialize. The Tree Frogs, *Hyla,* with their broadened toes, are well adapted for their climbing existence. They do not confine their movements to shrubs or trees, however. Some of them, such as the Canyon Tree Frog, *Hyla arenicolor,* live in boulder-strewn canyons in the arid Southwest of the United States. They blend so closely with the granite or sandstone rocks to which they cling during the day that it is difficult to make them out.

In general tree frogs are most abundant in such humid areas as Florida and the Gulf Coast. More kinds of frogs, *Rana,* are found in regions with heavy rainfall than elsewhere. In contrast, the toads, *Bufo,* being less dependent upon water, are more diversified in the dry Southwest. There are six kinds of toads in Arizona, for example, but only three tree frogs. Florida, on the other hand, has only two kinds of toads, but supports seven tree frogs.

Few places in the world can boast the frog choruses to be heard in Florida. One evening at the Archbold Biological Station near Lake Placid nearly a dozen kinds of frogs were calling within a few hours' time. In addition to the oak toad and the Carolina toad, there were three frogs, *Rana,* the Cricket Frog, *Acris gryllus,* the Narrow-mouthed Toad, *Microhyla carolinensis,* and four kinds of Tree Frogs, *Hyla.*

Each of these was breeding; each had its own distinctive call. That of the narrow-mouthed toad resembled the bleat of a young goat. The cricket frog, despite its name, *gryllus,* from the Greek word for "cricket," actually produced a sound more closely resembling the

note of the katydid. The call of the tiniest of them all, the Midget Tree Frog, *Hyla ocularis,* was a shrill "pe-teet," scarcely audible above the din produced by the two toads.

The Gopher Frog, *Rana capito,* was calling early in the evening but it was so wary that my companion, Dr. Raymond B. Cowles, and I could not approach it. We found some leopard frogs, and I was inclined to believe that this was the species we had heard. Finally, in the beam of our light we saw a gopher frog before it ducked below the surface. It swam several feet and then hid in the debris on the bottom of the pool. It was not until after midnight that the voice of the leopard frog was added to the chorus.

In Florida's summer rainy season it is not unusual to hear so many frogs calling simultaneously. In New England frog choruses are heard principally during the spring. There is a rather definite order of appearance. The Spring Peeper, *Hyla crucifer,* is invariably first, followed by the leopard frog. The wood frog is next, but there may be a few days' delay before the voices of the American toad, the pickerel frog, and the northern tree frog are heard, in that order.

The best time for capturing and studying the tailless amphibians is during the breeding season. The only equipment you need is a flashlight and a sack in which to carry the specimens. You should wear some old shoes that you do not mind getting wet—for you may have to wade into the water. But a few hours' work on a wet spring evening may provide enough frogs to stock your vivarium for the rest of the year. (A vivarium, by the way, is a moderate-sized enclosure, usually with glass sides, for keeping such animals indoors.)

Reptiles, Survivors of Past Glories

Reptiles have the distinction of being the first backboned animals that succeeded in laying eggs on land.

As far as we now know, the amphibians had been on solid earth for some fifty million years before one stock slowly changed its structure and its ways and became a reptile. This creature was the first that did not have to deposit its eggs in the water. The young no longer had to pass through the swimming tadpole stage we find in most frogs today. The reptile had overcome the handicap that tied the amphibian to the pools of its fish ancestor. And instead of laying eggs with a tiny yolk the reptile produced relatively large eggs, with sufficient food stored in them to permit the young to emerge fully formed, and ready to go about their business on land. Reptiles belong to the class Reptilia ("creeping animals").

It seems almost ironic that, having taken so many years to acquire the ability to breathe air and remain on land, some reptiles should later return to the water. However, some of them did return, and fittingly enough found that strong bonds now held them to the land—where they had to lay their eggs if the young were not to drown. One long extinct group of fish-eating reptiles, the shark-shaped ichthyosaurs, gave birth to fully formed young. This is also true of some of the modern sea snakes, which consequently do not have to go ashore.

But the gigantic marine turtles that glide so efficiently through the ocean depths are forced to make pilgrimages to the shore. Here they dig a cavity in the sandy beach and deposit the eggs, deep enough to hide them but not deep enough to prevent oxygen in the loose soil from readily reaching the porous covering of the egg.

REPTILES ARE COLD-BLOODED

Like other land dwellers, reptiles get their oxygen from the air. First they take in oxygen through the walls of a sacklike growth from the rear end of the developing embryo in the egg. Later on, after their lungs have developed, they breathe in oxygen. Moreover, in the course of their becoming land dwellers, the reptiles lost the moist glandular skin of their amphibian ancestor, and acquired a scaly covering for their body. This thickened skin protects them from enemies and prevents evaporation of their body fluids. These are the reasons why the reptile was the first backboned animal able to venture far from water, and eventually to invade even the driest of deserts.

The reptiles that remained reptiles, that is, those that gave rise to the dinosaurs and to our modern crocodilians, turtles, snakes, and lizards, never developed the ability to produce their own body heat. Some other branches of the reptilian group did acquire this ability; these continued the separate trends that eventually led to the birds and mammals. But the reptiles continued to depend upon the heat obtained directly or nearly directly from the sun.

The reptile is frequently called "cold-blooded" because it derives virtually all of its heat from sources outside its body. Little if any of the food it consumes is turned into heat. Even so, by sitting in the sunlight, or by pressing its belly against rocks or sand warmed by the sun, a lizard can absorb enough heat to raise its body temperature to relatively high levels. When it is active during the day a lizard is able to keep its body even warmer than that of many mammals and birds. Some lizards prefer to have their body temperature in the neighborhood of 104° Fahrenheit, higher than that of a human being. When the weather becomes too cold such reptiles are forced to retire underground where enemies or freezing temperatures cannot reach them.

Nonetheless there are some compensations in being cold-blooded. A man merely sitting in a room with the air temperature at 60° or 70° Fahrenheit uses up approximately forty times as much energy, largely to keep his body temperature at 98.6°, as a lizard were it of similar dimensions and not active. Rodents, bears, and some other mammals in cooler climates retire for the winter ("hibernate"). Reptiles in such regions do likewise, but, as their requirements are so limited, reptiles are able to live for much longer periods without nourishment. Many of the smaller lizards, snakes, and turtles have remained alive for as long

as a year without food. A large python has been known to survive for over three years without eating.

HOW CLIMATE AFFECTS REPTILES

The fact that reptiles cannot heat their bodies internally does, however, place restrictions on them: they cannot live in the colder portions of the world. Snakes are among the most cold-tolerant of reptiles; yet there are only twenty-two kinds or species in Canada in contrast to the 126 in the United States. None range so far north as Alaska in North America. In the Old World one European viper is encountered, it is true, slightly farther north than the Arctic Circle; but this is in the Scandinavian Peninsula, where a warm ocean current tempers the climate of the adjacent land. No reptiles are found where the subsoil is permanently frozen.

In general, reptiles are larger in tropical regions where they are represented by an abundance of species. It is doubtful whether many more remain to be discovered and added to the total of approximately seven thousand kinds or species now known. In the United States about 275 kinds or species are recognized, while all of Europe, lying somewhat farther north than the United States, contains only 103 species, including the five marine turtles that visit its shores.

SIZE AND SURVIVAL

Many more reptiles existed in the past. For some 160 million years reptiles dominated the world, in one sense. By modern standards some achieved the stature of giants. One ancient group even acquired somewhat batlike wings and took to the air. Another group took on body contours similar to those of the shark, with paddle-like limbs resembling fins, and took to the sea; here they preyed upon the relatives of their now remote ancestors, the fish. Still others sought sloughs and shallow waters where they could feed on the vegetation growing on the bottom or along the bank. On the other hand their cousins, the great flesh-eating tyrannosaurs, or "tyrant lizards," walked upright and remained on land, where they killed and devoured their reptilian relatives for sustenance. In short, the reptiles probably invaded all portions of the globe that were warm enough to allow them to be active

The ancient reptiles may not have required so much warmth as many of the present-day kinds.

But seventy or eighty million years ago reptiles went into a rapid decline. Perhaps it was in some obscure way due to the arrival of the mammals with their more advanced methods of caring for their young, and their ability to remain active in nearly all kinds of weather. Or perhaps there were violent climatic changes that were unfavorable for such bulky creatures as the dinosaurs and their relatives that had remained dependent upon outside sources for their body heat.

We may never know why the dinosaurs and their relatives perished, but it is possible that the climate became too warm for them. A creature the size of a rhinoceros or an elephant would have had great difficulty finding shade, let alone seeking cooler shelter underground. On the other hand, reptiles the size of most of our common lizards would have found it easy to cool their bodies by retreating into rock crevices, or by digging holes, as many of them now do in the hottest regions.

Large bodies of water do not gain or lose heat so rapidly as land does. If the extinction, or failure to survive, of the large reptiles came about through extensive climatic changes, those living in rivers, lakes, or oceans may have been less severely affected. And so it is probably significant that the heaviest and largest reptiles in existence are creatures that live in rivers or oceans.

THE BIGGEST REPTILES ALIVE

The crocodilian cousins of the gigantic reptilian rulers of the past managed to survive, and today they are the largest reptiles in existence, at least as far as weight is concerned. Some pythons may exceed the largest crocodilians in length, but probably never weigh more than four hundred pounds. In contrast, some of the largest crocodiles may weigh more than a ton. For obvious reasons few of the really large ones have been weighed. Some sea turtles weigh over three-quarters of a ton. The weight of a Pacific Leatherback, *Dermochelys coriacea*, captured off the coast of Santa Barbara, California, is recorded as 1,575 pounds. Even greater weights may be attained.

At any rate, most of the living reptiles are not large creatures. In general the largest ones live in the warmer oceans, or in tropical re-

gions where cold winters are unknown. Contrary to popular belief, it is never so hot in the tropics as it is in the desert regions farther from the equator, in what are so ineptly called the "temperate zones." The dozen or so principal groups or Orders that formerly existed have dwindled to four. These are the crocodilians, the turtles, the lizards and snakes (the latter two belong to the same major group or Order), and the *Rhynchocephalia,* of which all members but one, the Tuatara, are known only as fossils.

The Crocodilians—Living Giants

THE ALLIGATORS, caimans, crocodiles, and gavials together comprise the group known as the crocodilians, which includes the largest reptiles in existence. They are found in rivers or along the margins of oceans or in lakes throughout most of the tropics, as well as in the warmer, moist regions of the temperate zone. Although only twenty-five kinds are recognized, several of them are abundant in certain localities. They are an important group of reptiles, aside from the commercial value of their hides which are widely used in the leather industry.

All of them dwell in water, where they prey upon a vast variety of other animals. Those with long slender snouts live in India and the Malay region. They are known as Gavials, *Gavialis*, a corruption of the Hindu name *gharial.* The true crocodiles are more widespread, and occur in all continents except Europe and Antarctica. All of them have a few teeth in the lower jaw that are larger than the others and that fit into notches on each side of the upper jaw. This gives them the grinning appearance that distinguishes them from the alligators, whose enlarged teeth fit into pits in the upper jaw. Crocodilians make up the order Crocodilia.

THE ALLIGATORS AND CAIMANS

The existing crocodilians are divided into only three families, Gavialidae, Crocodilidae, and Alligatoridae. The gavials are sparsely distributed in India, the Malay Peninsula and the East Indies. Crocodiles are found in suitably moist regions throughout the tropics. The alligators, which together with the caimans of Latin America, make up the family Alligatoridae, are largely restricted to the New World. The only exception is the Chinese Alligator, *Alligator sinensis,* which is now nearly extinct.

The American Alligator, *Alligator mississipiensis.* Prior to the coming of man, alligators were extremely abundant in parts of the United States, particularly in Florida. Early explorers described such places as the St. Johns River as being so full of alligators that it might have been possible to walk across, using the 'gators' bodies as stepping-stones, had it not been for the aggressive nature of these large reptiles.

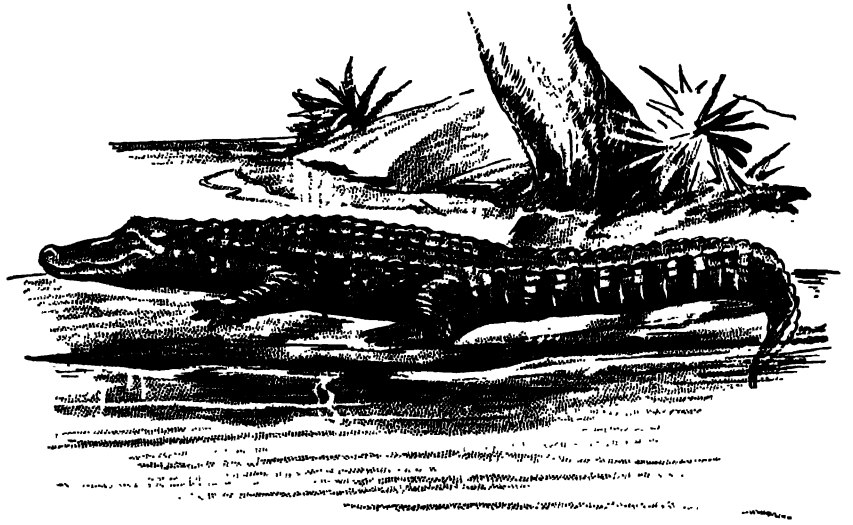
——THE ALLIGATOR'S REPUTATION AS A MAN-EATER. Instances of alligators attacking humans are rare. However, in 1949 according to reports of the Fish and Wildlife Service, an eleven-foot alligator in the Okefenokee (Georgia) National Wildlife Refuge developed the habit of stalking fishermen and visitors along the canal. The Refuge agents roped the crocodilian and turned it over to the Okefenokee Swamp Park, where visitors could study the animal.

Occasionally there are reports of alligators charging small boats, but more often such reports are put forth as pretexts for killing larger individuals, which in some areas are protected by game laws.

——THE THREAT TO THE ALLIGATOR. It has been estimated that over two and a half million alligators were killed in the state of Florida alone between 1800 and 1900. By the turn of the century they were already exterminated in parts of their range. The demand for their hides resulted in their being killed more rapidly than they could reproduce. Moreover, thousands of young were sold as pets, or killed and stuffed to be sold as souvenirs. Fortunately many of the refuges established primarily for the protection of waterfowl contained alligators, and these were also protected. Alligator havens have now been established in Louisiana, Georgia, and South Carolina, with some smaller ones in Florida; and this interesting reptile is no longer in danger of being removed from the face of the earth.

However, despite these efforts at preservation, hunting has greatly reduced the number of alligators. The remaining animals rarely if ever survive to reach the great size of eighteen feet observed in some alligators as late as the beginning of the twentieth century. Alligators of even half this size are uncommon today, although small ones a yard or so long can readily be seen, even in roadside pools in Florida. The larger ones are usually found in lakes or in the deeper rivers.

——How the Alligator Moves and Gets Its Food. Occasionally alligators are forced to make an overland journey, but as with all crocodilians their main activities are closely associated with the water. They swim by means of sinuous movements of their muscular tail, in



THE VANISHING ALLIGATOR

As their tough hide is in demand for a variety of uses, alligators have been slaughtered in vast numbers in the United States. In Florida alone, it has been estimated, over two million were killed during the nineteenth century.

somewhat the same general way that a mackerel does, with their feet playing no important part in the propulsion. On land they are rather clumsy, slow, and deliberate in locomotion, although they carry their body high off the ground, with just the tip end of the tail dragging. When provoked, however, they lunge forward with great rapidity, or wield their tail as a powerful defense weapon.

During the daytime alligators are usually seen basking; they do

much of their feeding at night. Young alligators eat such crustaceans as crayfish and shrimp, as well as insects. As they grow larger they devour snakes and turtles, fishes, birds, frogs, and muskrats. Cannibalism has been reported. Larger alligators even prey upon raccoons, and reputedly sometimes attack animals as large as a bear.

——THE ALLIGATOR'S FAVORITE HAUNTS. Alligators make burrows, dens, or "'gator holes" as they are called, in the banks of rivers. These serve as places of retreat during the summer. During the winter they retire to these caves or sometimes sink into the mud, leaving a hole to the surface to permit the limited breathing that is necessary when they are inactive. They cannot tolerate high temperatures. A few minutes' exposure to body temperatures only slightly higher than 100° Fahrenheit is sufficient to cause death. They appear to prefer temperatures between 75° and 85°. In the cooler streams of Florida middle-sized or larger individuals are commonly seen basking at the surface of the water, buoyed by the air in their lungs.

——HOW THE ALLIGATOR BREEDS. The heat of the sun is probably of importance in the incubation of the eggs. Ordinarily only twenty to thirty are laid by mother alligators of the size now attained. Formerly very large females may have laid more than twice that many. The female deposits her eggs in a nest that she makes by gathering vegetable trash and mud. Sometimes the nest may be over a yard high, and more than six feet across. After laying the eggs she covers them with the same sort of trash used in constructing the nest. She leaves a small opening to allow the young to escape when they hatch about eight weeks later.

The mother alligator is one of the few reptiles that remains on guard in the vicinity of the nest. Presumably she prevents such animals as skunks and raccoons from removing the eggs. In bygone days when occasional females may have reached the length of eighteen feet or so, any animal venturing into the vicinity was probably attacked. According to some accounts, the female by means of grunting noises calls the young to her den as soon as they emerge from the egg. However, they apparently remain with the parent for a relatively short time, for small alligators take up residence in smaller, often quite shallow, ponds at least a mile or so from any breeding site. In Florida they sometimes move into fish ponds, or drainage ditches.

——THE ALLIGATOR'S SENSE OF HEARING. The ears of alligators are well developed, but they are hidden under a flap not far behind the

eyes that few people notice unless it is called to their attention. If this flap is lifted with the fingernail, as it can be in small captive specimens, a rather large eardrum is disclosed within a cavity. It is evident that alligators hear at least as well as humans. On the Caloosahatchee Canal in Florida the Lockmaster told me that one living near the end of a small pier had learned to respond to a call after it had been fed a few times. To show how well trained the 'gator was, the Lockmaster walked to the end of the pier and shouted, "Toby!" Sure enough, within a few seconds a four-foot alligator emerged from the depths.

——How Alligators Develop and How Long They Live. The alligator's growth is relatively rapid at first. An alligator eight inches long when it emerges from the egg will more than double its size during its first year of life. It adds about a foot each year until it reaches a length of approximately ten feet. Thereafter the rate of growth tapers off, with only a few inches being added annually.

No one knows the maximum life span of any crocodilian. However, an alligator has been known to live for at least sixty-eight years, and it is reasonably certain that some exceed a century. Nonetheless there is no actual proof for the claims often made in the show places calling themselves "alligator farms" that alligators attain ages exceeding five hundred years.

Living Fossil—The Tuatara

The Tuatara, *Sphenodon punctatum*, is the sole survivor of an ancient group of reptiles, the order Rhynchocephalia or "beak-heads." The early ancestors of the tuatara were a branch of the main reptile stem that later on led to the dinosaurs. Turtles were already in existence, but few other groups had made their appearance. The lizards came later and gave rise to a number of families as well as to the snakes.

The beak-headed reptiles, however, were not destined to achieve importance. When the dinosaurs were becoming diversified many of them attained great size. The ancestors of the tuatara were neither large nor abundant. As far as we can judge by the limited fossil record, none was ever much larger than a five-foot alligator. However, the beak-heads did become dispersed over much of the earth.

The dinosaurs failed to survive—perhaps, as has been conjectured, because of climatic changes, perhaps for other reasons. The beak-heads might well have followed them into extinction had not the tuatara, in some unknown manner, reached the distant outpost of New Zealand.

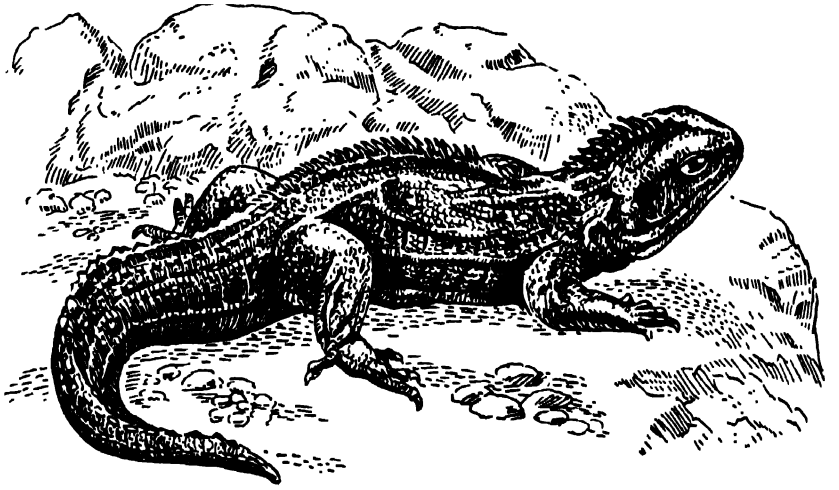
THE "LIVING FOSSIL"

Here the tuatara lives among the rocks in a cold climate that few other reptiles could tolerate. At one time it lived on the New Zealand mainland, where the first settlers from England made its acquaintance. The native Maori knew it long before the arrival of the European. It was the Maori who gave it the name *tuatara*. Over a century ago it was given the specific name *punctatum*, meaning "spotted," and later assigned to the genus *Sphenodon* or "wedge-tooths." To scientists it is *Sphenodon punctatum*—a reptile superficially similar to some lizards, which it resembles in being able to regenerate its tail, yet so distinct from them in its fundamental structure that it can be recognized as the only remaining representative of the beak-heads. For this reason it is often referred to as a "living fossil."

Today the tuatara is gone from the mainland, exterminated by man and the animals he brought to New Zealand with him. The only survivors now dwell on some small islets in the Bay of Plenty and in Cook Strait north of Auckland. By day the tuatara lives in a burrow, venturing forth after sunset to feed on snails, crickets and other small animals. Like some other reptiles that are active during the hours of darkness, the tuatara has a voice. Its croak is often heard in the islets where it is now restricted, especially on Stephens Island, which may contain as many as five thousand of these reptiles.

The tuatara deposits its eggs in a depression dug in the earth, sometimes laying as many as fourteen. The young do not hatch until almost a year later, when they break the parchment-like shells and dig their way to the surface. Upon emergence the young tuatara is about

four and a half inches long. Its growth is not especially rapid, and no one knows how many years it requires to reach its maximum length of slightly over two feet.



SURVIVOR FROM DINOSAUR TIMES

One of the more amazing survivors from dinosaur times is New Zealand's tuatara. A somewhat lizard-like creature, it is the last of its kind, all of its relatives having disappeared from the face of the earth well over a hundred million years ago. Tuataras are long lived —several are known to have survived over twenty years.

THE TUATARA FLOURISHES IN CAPTIVITY

The tuatara is a long-lived creature. One kept in the Dublin Zoological Garden was still alive after twenty-three years when its age was reported. A fifteen-inch specimen in Upsala, Sweden, was alive after twenty-eight years, although it had grown little if any during that period. It was fed on earthworms and raw meat cut in strips, which it ate willingly. It remained quite lively, occasionally immersing itself in the water in its cage. After years of captivity this individual was quite tame. Mr. William Dawbin, writing in the New Zealand journal of natural history aptly named *Tuatara,* reports that a tuatara was kept in captivity in New Zealand for well over half a century.

The Turtles—Reptiles with Armor

TURTLES are proverbially slow-moving and as they have no weapons of offense—with the exception of the snapping turtles—their preservation for 200 million years strikes us as very puzzling. The secret of their survival lies of course in their tough horny shells which have successfully provided them with shelter and protection. The turtle's shell is both a house and a coat of armor.

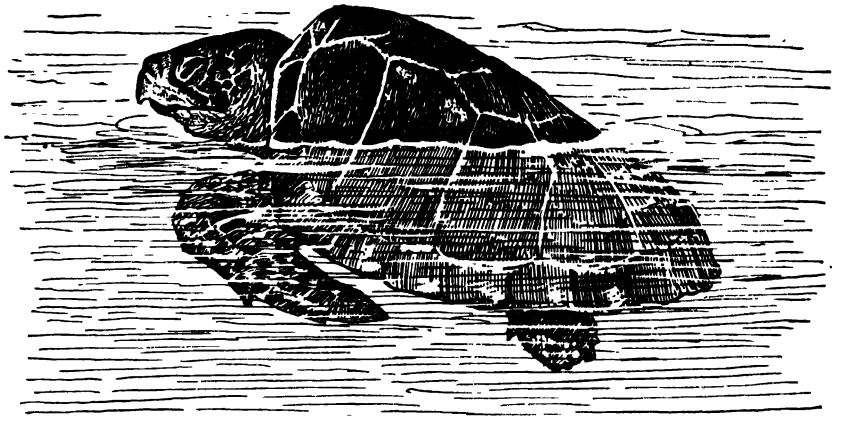
THE CONSERVATIVE TURTLE

All the changes that led to the armor took place countless ages ago before there were any crocodilians, lizards or snakes. There were no birds and no mammals. The dinosaurs had not yet appeared. To be sure, amphibians and other reptiles were in existence then—but none bore any close resemblance to anything now living. Over 200 million years ago the turtle alone, of all the surviving groups of backboned animals, had become essentially what it is today. And a turtle it remained, giving rise to the reptiles that comprise the order Testudinata (or Chelonia).

Since that distant time the changes in the structure of the turtle have been relatively minor. The original stock gave rise to more advanced lines—always turtles, for no major offshoots ever occurred. One group, the Side-necked Turtles, continued to protect the head by curling the neck around the front of the body. Another more successful group evolved a better means of protecting the head—by withdrawing it into the shell in a vertical S-shaped arrangement. Still others, the Box Turtles, *Terrapene,* for example, went beyond this. By developing hinges at the front and back of the bottom part of the shell the turtle was able to withdraw its head as well as its tail behind closed "doors."

Some turtles reversed the amphibian-to-reptile trend and returned

to water. A few of these, including some of the larger ones, acquired flipper-like limbs and made the oceans their home. Other turtles took to fresh water, and many more remained on land or alternated between land and water. Turtles succeeded in reaching all continents, but they thrived in relatively few habitats. There are few more than fifty species, including the ocean dwellers, in the United States. In all of Europe there are but seven, although five additional kinds, marine turtles, reach its shores. There have been no land or fresh-water turtles in the British Isles in recent times.



THE LOGGERHEAD TURTLE—IT HAD FABULOUS ANCESTORS

The loggerhead's shell is sometimes large enough to serve as a small rowboat. Though loggerheads are not likely to exceed three hundred pounds nowadays, we have evidence that they were much bigger in former times. Their weight may have approached half a ton in the days before they were hunted so extensively along the coast. These monsters had a head almost a foot wide.

The structure of the turtle, with its body encased by the covering of bone and horny plates, has proved adaptable to its environment in some ways, but in comparison with other reptiles it has limitations. Turtles manage to dig burrows, although none actually "swim" through the sand as many lizards or snakes do. Unlike several of the latter reptiles, no turtle climbs trees. And needless to say, none has ever managed to fly—or even to glide, an accomplishment of an ancient group of reptiles and of some lizards and at least one snake in recent times.

All turtles deposit their eggs in holes in the earth, regardless of

whether the adult lives on land or in the water. The marine turtles could avoid many hazards if they were able to give birth to fully-formed young. The time and energy required to seek land could profitably be devoted to more useful ends. Many sea snakes, for example, give birth to their young without going ashore. But, as we have seen, all turtles adhere inflexibly to the ancestral egg-laying habit.

So the turtle may be considered a conservative. The encased and armored body has its advantages—200 million years' worth, we might say, but the limitations are also obvious. Of some seven thousand kinds of living reptiles, scarcely three hundred are turtles. It is doubtful whether they were ever much more numerous. Evidence from the fossil record suggests that there may have been a slight peak of abundance about 100 million years ago. Even if this is borne out by future discoveries it was a doubtful heyday.

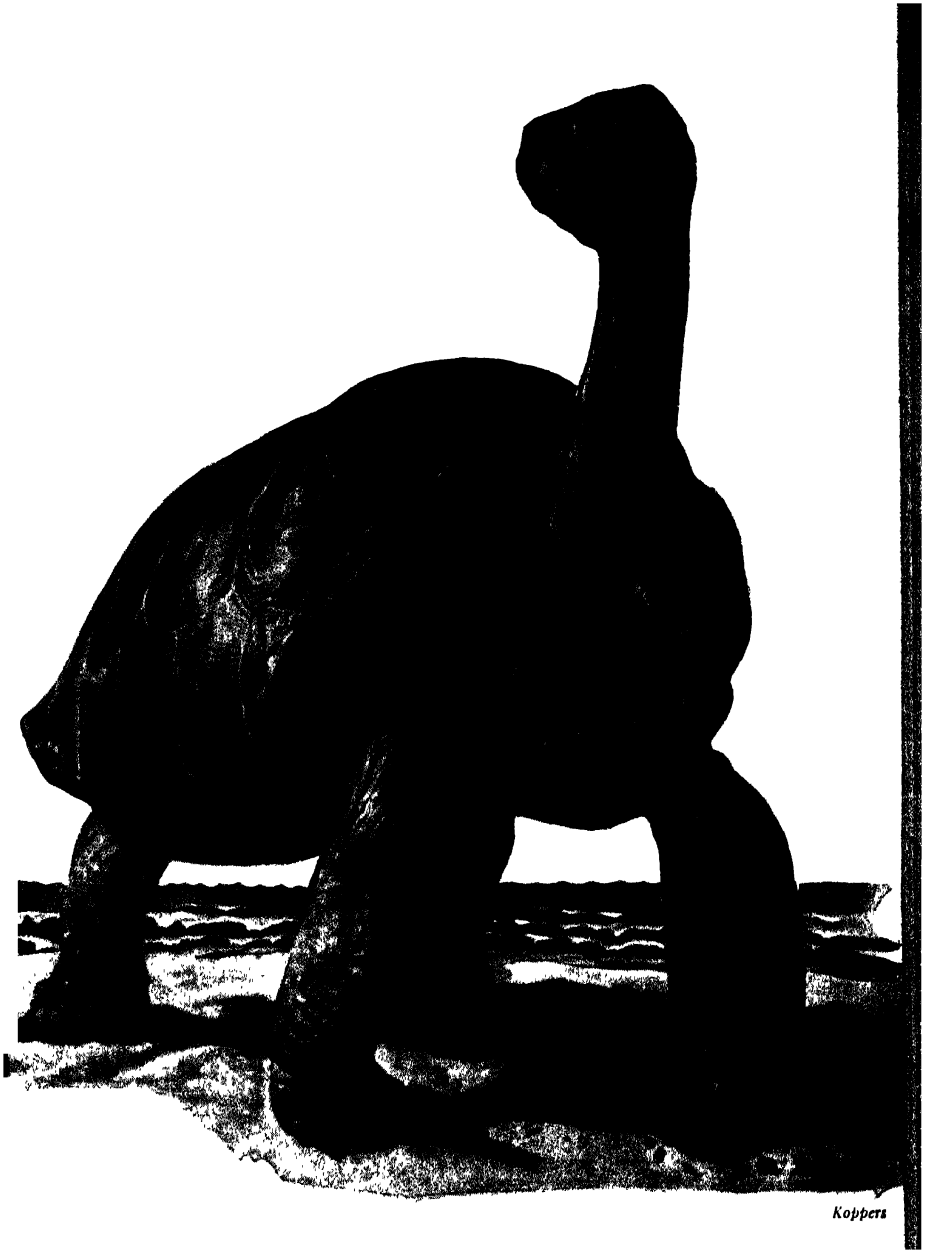
TURTLES LIVE LONGER

Turtles are persistent creatures, as stubborn in other respects as they have been in their retention of the ancestral form. Tenacious of life, they live longer than any other backboned animals. There is reasonably good evidence that a tortoise on the island of Mauritius lived for at least 152 years. If it had not been killed accidentally, it might have reached the two-century mark. No bird or mammal can approach this record.

Turtles are more vulnerable while they are still in the egg, or immediately after they hatch. At first the shell is soft, but it hardens within the first few years of life and becomes thicker. It is probable that a good many turtles attain relatively great ages, once they have survived the first few critical years. The Common Box Turtle, *Terrapene carolina,* not infrequently lives for over half a century, and possibly reaches a maximum of 123 years.

TORTOISES, BOX TURTLES, POND TURTLES, AND THEIR RELATIVES

Turtles, including ancient fossil types, have been divided into eighteen families, half of which are still in existence. Among the more successful of the turtles are those in the family Testudinidae. The turtles commonly seen in the Northern Hemisphere are mostly members of



A QUARTER-TON TORTOISE

The giant tortoises of the Galápagos Islands may gain as much as forty-five pounds a year, and some have survived for more than a century. However, most of their growth is attained during the first decade of life. Five-hundred-pounders still survive only in the more inaccessible portions of the Galápagos Islands. Unless protected, they may follow the dinosaurs into oblivion.

this family, although several representatives have penetrated into both Africa and South America. Most parts of the United States contain one or more kinds of tortoises, box turtles, sliders, or their relatives.

The Box Turtle, *Terrapene carolina,* is a dome-shaped creature, with the plastron, or bottom of the shell, flat and connected by a bridge at the sides to the top or carapace. Usually there is an inconspicuous ridge running the length of the back. The whole bony shell is covered with horny plates about as thick as a thumbnail. Colors vary quite a bit, with yellowish spots, blotches, or stripes on a brown or blackish ground color. The turtle's head is rather small, the snout ending in a sort of overhanging beak that is notched in some races, and not in others.

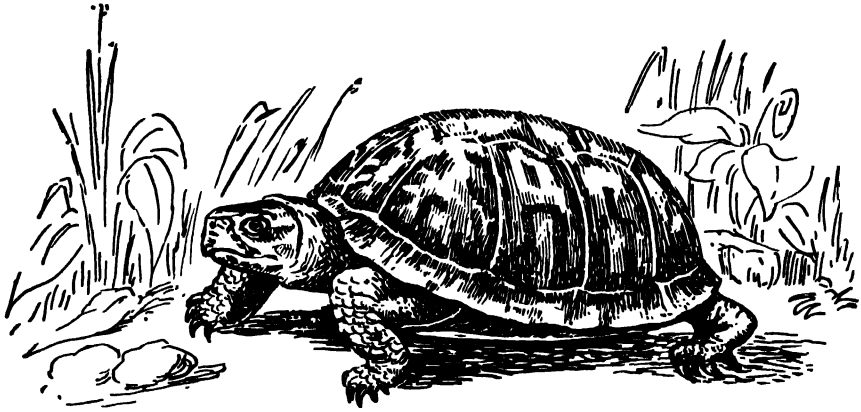
Both the front and back of the bottom of the shell are hinged at the bridge. When molested the box turtle withdraws its four limbs as well as its head inside the shell, which can then be closed tightly at both ends. A few other turtles have similar hinges in the plastron, and an African species has the carapace hinged near the middle. None, however, manages to close the shell so tightly as the box turtle does, especially the race in peninsular Florida.

——WHERE BOX TURTLES ARE FOUND. Several races or subspecies of box turtles are found in eastern North America, all the way from New England to Yucatán in Mexico. Those in the North usually have four toes on the hind feet, while others in the South ordinarily have but three. The Ornate Box Turtle, *Terrapene ornata,* is a closely related species that dwells in arid regions east of the Rocky Mountains, as well as parts of Texas, New Mexico, Arizona, and northern Mexico.

——THE BOX TURTLE'S SIZE AND COLOR. Box turtles in the northern region of the United States are rarely more than half a foot long. Ten to twenty thousand years ago they commonly attained greater dimensions, and some extraordinarily large individuals still turn up in one area in northern Florida. Eight inches or a little more is possibly close to the maximum size of any now living. The male, commonly the larger of the sexes, has a concave area in the rear of the plastron, which is flat in the female. The iris, or pigmented area surrounding the pupil, is generally pink or bright red in males, and dull brown, or dark red, sometimes even purplish or gray in females.

——WHERE THE BOX TURTLE LIVES. The common box turtle is usually found in wooded areas, at sea level as well as at elevations as high

as four thousand feet. Primarily this turtle is a land dweller. During the hot summer months, however, it is more likely to be in densely shaded areas along streams. Often it is actually in the water, where it floats keeping its head and the upper third or more of its domed shell above the water. Or it may swim beneath the surface, which it does somewhat more awkwardly than the strictly water-dwelling turtles with their flatter shells.



THE HARDY BOX TURTLE

Turtles have changed little during the past two hundred million years. These sturdy creatures outlive all other backboned animals. The box turtle, a typical member of the clan, has horny plates about as thick as a thumbnail.

——How the Box Turtle Moves About. The box turtle is slow and extremely deliberate on land. Mr. John T. Nichols, who has studied these reptiles on Long Island in New York for many years and probably knows more about them than anyone else, tells me that it took one of them fifteen minutes to travel some forty-six yards. This was its ordinary cruising speed, which he figures is about a mile in slightly more than nine and one-half hours! He believes that a large, active male might possibly go a mile in four hours, but that the maximum speed the best of them could attain would not be much more than a half mile per hour. They could keep up such speeds for short distances only.

——The Box Turtle Sticks Close to Home. Mr. Nichols' observations of these turtles on Long Island show that each leads a more or less solitary life, most of it spent within a rather well-defined area.

The radius of their home territory is usually less than 250 yards but may be as much as half a mile. Adult turtles removed three-quarters of a mile usually return to their home territory, whereas young turtles, under four inches long, are much less inclined to return. In any case, if turtles are taken several miles away they do not attempt to go back. This suggests that they may become familiar with areas somewhat larger than the restricted home territory. But with no landmarks in sight they have no urge to return.

In the course of years, box turtles may shift their home territory slightly; but they show a marked inclination to remain in one area. In order to be able to recognize them later, Mrs. Lucille Stickel marked a number of them living on the flood plane of the Patuxent River in Maryland. At the time of a flood she found several clinging to vegetation, but none had been carried away from the home range. After the flood waters had subsided, virtually every turtle found by Mrs. Stickel was near the place where she had first discovered it. Years ago Oliver P. Medsger told how he had marked a box turtle, and found it thirty-five years later within 150 yards of the original spot.

——THE DAILY LIFE OF THE BOX TURTLE. Within its home range the box turtle wanders at random, but with a strong sense of direction. It burrows in leaf mold at night, always emerging by plowing forward. It is most active during warm rains, or just after sunrise and before sunset. Box turtles drink with the head submerged while muscles in the throat draw the water into the body. A large individual consumes as much as four ounces at one time.

——THE HIBERNATING BOX TURTLE. Box turtles lose moisture rather rapidly when they are exposed to dry air. A Florida Box Turtle, *Terrapene carolina bauri,* lost nearly one-fifth of its weight during a forty-five-hour period that it was kept in a chamber in dry air at a temperature of 100° Fahrenheit. Like its northern relative, the Florida box turtle goes underground during dry weather, as well as in the winter when temperatures are low. During a hot summer at Yaphank on Long Island in New York, George Englehardt found several common box turtles that were buried from six to ten inches deep in the mud bordering a cranberry bog.

The common box turtle has also been found hibernating buried beneath the surface. In Maryland the site it chose was a gentle slope at the edge of a woods. In warm years the box turtle remains abroad as late as early December, and leaves its winter quarters as early as

March 1. It does not ordinarily begin to breed until the onset of summer.

——THE BOX TURTLE'S BREEDING HABITS. Mating may occur throughout the season when the box turtle is active, but it has been observed more often during the spring and fall. On such occasions the male follows the female about, biting her shell or exposed skin. He lunges against her, pushing her about in an effort to subdue her. When his advances are no longer avoided, the male finally works his legs into the cavities in front of her hind legs. She grips his hind legs with hers and, with the shell of the male raised to an upright position, the tails are brought together. After the eggs are fertilized a thin, white shell on a parchment-like cover is formed over them and they are ready to be laid. Some turtles produce fertile eggs for as many as three or four years following one mating.

In the District of Columbia, H. E. Ewing observed females digging their nest between June 22 and July 14. They hollow out a flask-shaped cavity in soft soil, the female invariably beginning the task in the late afternoon or early evening. She anchors her body with her forelimbs and digs with her hind legs, using them alternately. She requires from three to five hours before she has dug to the limit she can reach. Sometimes the turtle encounters a root or a rock, in which case she may discard the site in favor of another.

After completing the excavation the female rests a few minutes before she drops the first egg to the earth loosened at the bottom of the hole. Usually she lays three or four or even as many as eight eggs one by one, covering each with earth scraped from the sides of the hole. She presses the earth carefully onto the eggs, until she has deposited the entire clutch. With the hole nearly filled, she reaches out for the dirt on the surface, packing it down by means of treading movements. When she has finished, the female sometimes voids the contents of her bladder on the spot. She has concealed the site so well that it is virtually invisible.

The eggs, which are roughly one and a quarter inches long and three-quarters of an inch in diameter, are white and elliptical, with thin but hard shells. Incubation requires most of the summer. The hatchling, like most other reptiles, is equipped with an "egg tooth" (not a true tooth, as it is in snakes and lizards) at the tip of the snout, although Ewing found that this was rarely used to slit the covering of the egg. More often the young turtle rips a lengthwise slit, using the

claws of its front or hind limbs. Once out of the egg, the hatchling digs its way to the surface, but not necessarily at once.

Eggs ordinarily begin to hatch in September, but some may not do so until late in November. In the northern part of the box turtle's range it is not uncommon for the fully-formed turtle to spend the entire winter inside the nest. Even if it were on the surface, the hatchling would go into hibernation without feeding. Commonly some yolk remains after the turtle is fully formed, and this serves to tide the small creature over until spring.

It is usually extremely difficult to find the juveniles, which are generally about an inch and a quarter long when they come out of the egg. Their small size doubtless makes them less noticeable than the adult. So few of them are found, however, that they must be more secretive than adults. Their growth is relatively rapid, apparently, with almost an inch being added to their length each year. They reach maturity at the end of four or five years, when the female is approximately five and a quarter inches long. On Long Island Mr. Nichols found that most of the common box turtles over five and a half inches in length were males, which evidently tend to be the larger of the two sexes.

——THE BOX TURTLE'S VARIED DIET. Box turtles devour an astonishing variety of food, including both plants and animals. They are particularly fond of mushrooms and toadstools. According to some authors, turtles are careful to avoid poisonous toadstools, but others maintain that the toadstools are eaten. No one has settled the question. Slugs, snails, earthworms, caterpillars, succulent leaves, berries, and even carrion make up portions of the diet. On rare occasions box turtles do some damage in gardens, where they eat tomatoes or strawberries. Young individuals will eat the beetle larvae commonly known as "meal worms," although adults often refuse to eat them. Turtles in captivity have accepted lettuce, melon rinds, bananas, and bread. One captive turtle is known to have lived for an entire year without either food or water, although it must have been kept in moist surroundings at moderately low temperatures.

——THE BOX TURTLE'S ENEMIES. Despite their bony, horn-covered shell, box turtles are vulnerable to the attacks of several dangerous enemies. Skunks not infrequently dig their eggs from the nest, and probably devour a few hatchlings. Sometimes adult turtles become so fat that complete closure of the shell is impossible. Julius Hurter tells

how he discovered a large brown rat gnawing at the shell of a live box turtle in Missouri. The poor reptile had been turned on its back and was covered with blood. The rat had bitten through the skin of the hind foot, which could not be drawn into the shell. The turtle probably would have been killed if Mr. Hurter had not interrupted the rat's meal.

In Indiana Glenn Culbertson watched from a distance as a number of hogs came upon some box turtles. Several of the hogs picked up turtles, but only the largest of them succeeded in crushing the shells. Squealing for their share, many of the smaller hogs joined the larger ones in devouring the contents.

On occasion an attacker may not fare so well. W. D. Funkhouser describes a combat that he witnessed between a snake and a box turtle on the Dix River in Kentucky. A water snake seized the head of a box turtle while it was swimming. The turtle quickly closed its shell, catching the head of the snake between the plastron and the carapace. Both animals sank to the bottom of the river, but in a few minutes the lifeless body of the snake appeared on the surface, its head crushed.

The automobile has become an increasing hazard to box turtles. Their broken, flattened bodies are commonly seen on the highways through wooded areas in the East. The Ornate Box Turtle, *Terrapene ornata*, of the western plains, is killed so frequently by automobiles in some sections that many casualties must be attributed to intentional killing by misguided drivers who go out of their way to run over the slow-moving beasts. In the sand hills of western Nebraska and on into Colorado during the spring, I have driven through areas where dead turtles of this species dotted the highway, sometimes as many as three or four within a mile.

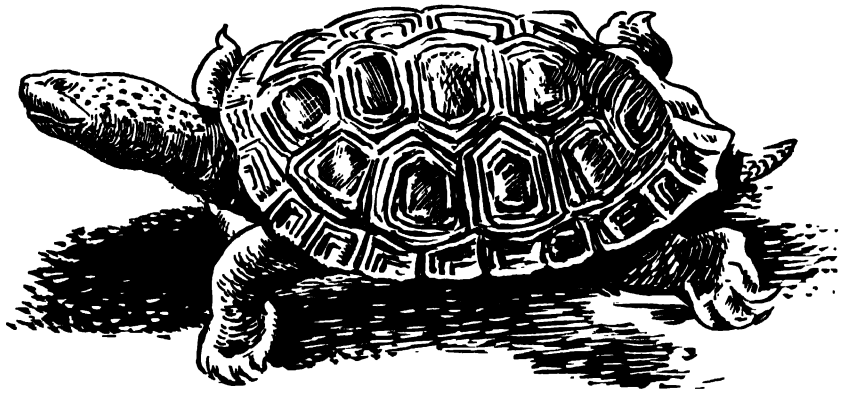
Fires destroy an unknown number of box turtles, particularly in Florida where the burning of hammocks (areas with dense vegetation) is a common practice. A fair number of these turtles apparently manage to burrow into the earth, thereby escaping with their lives but with scorched, mutilated backs. Virtually every Florida Box Turtle, *Terrapene carolina bauri*, that I have captured had the bone exposed and the horny shell missing from the middle of the back. Such "fire scars" probably persist throughout the rest of their lives.

——PARASITES ON THE BOX TURTLE. More subtle in their aggressions, if not so deadly, are the parasites that infest box turtles. Ewing found some turtles in Maryland covered with the larvae of the common

American chigger, the pernicious mite that occasionally causes severe irritation on the skin of human beings. Even more insidious are the infestations of the turtle flesh flies. These insects deposit their larvae on the soft parts of turtles, where the grubs bore their way into the skin. Here they grow at the expense and to the discomfort of the turtle. When fully grown and perhaps a quarter of an inch in diameter, the grubs emerge and fall to the ground. Here they burrow into the earth to pupate before they appear as adult flies. Meanwhile the former host is left with a gaping hole in its limb or neck.

——Box Turtles as Pets. Fortunately, relatively few turtles are infested in this way. Most box turtles are handsome animals, ideal for observation in captivity. Few reptiles are so easily kept in confinement. They should be provided with water for drinking or soaking and with some moist leaves or rotting vegetation in which to burrow at night. To dig her nest, the female needs sandy soil exposed to direct sunlight. Some access to shade is necessary, however, for prolonged exposure to direct sunlight can be fatal to turtles.

——Turtle Terminology. The common box turtle is sometimes referred to as a "tortoise," although most people who write or talk about reptiles prefer to use this name only for such land dwellers as the Desert Tortoise, *Gopherus agassizi*, which rarely if ever enters the water. "Terrapin" is another name, of American Indian origin, which



THE DIAMOND BACK TERRAPIN—GOURMET'S DELIGHT

This turtle of the tidal waters of the Atlantic coast of America brings higher prices, pound for pound, than any other turtle. So succulent is its flesh that fashionable hotels have paid almost a hundred dollars a dozen for the terrapin.

some use rather loosely. Others would apply the term only to turtles more commonly used for food—the Diamond Back Terrapin, *Malaclemmys terrapin,* for example. These are all turtles, or, more technically, members of the Order Testudinata.

The Slider, *Pseudemys scripta troosti.* Another common inhabitant of streams in the eastern part of the United States is called Troost's Turtle in books, but it is more generally known by the popular name of "slider." The small turtles most often sold in pet shops are juvenile sliders, a species that is unbelievably abundant in many parts of the Mississippi Valley, from Illinois southward to Louisiana.

Dr. Fred Cagle, who has made an intensive study of the habits, behavior, and breeding of the slider turtle, has collected by hand or trapped over eight thousand individuals. He concluded that eight out of every ten turtles inhabiting the fresh waters of Louisiana are sliders. Thousands upon thousands are shipped annually from Louisiana to pet shops throughout the United States. Some of these are hatchlings from eggs incubated under artificial conditions. Cagle reports that three collectors dug more than three thousand eggs from nests in a railroad embankment in a single afternoon. Such incredible inroads may eventually reduce the numbers of sliders in the immediate region of the raids. Thus far, however, there has been no perceptible reduction in the turtle populations.

Sliders, so called from their habit of sliding into the water upon the approach of an intruder, live mostly in the water. They feed there habitually, ordinarily venturing on land only to breed or to bask except during the spring and late summer. During these times of the year there are overland migrations that probably account for the presence of sliders in all suitable waters within their range.

——THE SLIDER'S APPEARANCE. Except for old males, sliders are rather flat, greenish-colored turtles with yellowish streaks on their head and neck. Their most characteristic marking, however, is a bright red line that extends from behind the eyes to the back of the head. The male matures in from two to five years, when its plastron, the bottom part of its shell, is three and a half to four inches long. The female is not ready to breed until her plastron is from six to eight inches long.

Aside from being much smaller than the female, the male is easily distinguished because its front claws are twice as long as its hind ones.

In females the front and hind claws are about the same length. Unfortunately these differences hold only for adults; there are no external characteristics that enable us to determine the sex of the juveniles sold in pet shops.

The female undergoes no conspicuous change in color while she is growing. But the male frequently becomes increasingly blacker in its old age until it is almost impossible to discern any markings whatsoever. The two sexes are so strikingly different that for decades naturalists believed the black males represented a distinct species. Now that they have observed the courtship, there is no question concerning the identity of the two. Moreover, the purpose of the long claws on the male has become apparent.

——COURTSHIP AMONG THE SLIDER TURTLES. During the spring or fall the male pursues the female, repeatedly swimming in front of her and facing her. Sometimes three or four males will court a female at the same time. Eventually one of them manages to get himself in the proper position. There in front of the female, the male draws his forelimbs together and vibrates his claws against her head. If she is receptive, she swims along slowly, allowing the male to continue to stroke her chin and cheeks as he swims along backwards. Finally she sinks to the bottom, with the male in pursuit. The pair complete their courtship while they are on the bottom, often in water so deep that an observer has difficulty in watching them.

——FROM EGG TO ADULT. The female slider lays from one to three clutches of eggs between April and the middle of July. Each clutch may contain from four to twenty eggs, depending on the turtle's size. In order to deposit her eggs the female leaves the water to seek an open spot where the soil is not muddy. Sometimes the turtle chooses the summit of a hill; often she must travel several miles to find a suitable nesting site. She digs out a jug-shaped hole with her hind legs, and if the ground is hard she releases fluid from her bladder to soften it. Cagle reports that some turtles need more than three hours to dig the nest, whereas others succeed in less than half an hour. Owing to the turtle's shyness, however, Cagle never succeeded in watching the actual laying of the eggs.

The eggs hatch throughout the summer, from July to late September. Those in individual clutches require from sixty-eight to seventy days, depending upon the temperature of the nest. The eggs vary in size but average an inch and a half in length and seven-eighths of an

inch in width. When the hatchling is ready to emerge it cuts one end of the egg, using either the temporary "egg breaker" on its snout or its front claws; sometimes both the tooth and the claws are used. Upon emerging the hatchling is approximately an inch and a quarter long.

Like the young of the box turtle, those of the slider do not always come out of the nest when they have hatched. They may spend the entire winter in the nest, relying upon the large yolk mass to sustain them. Once they start to feed, however, their growth is quite rapid. Cagle found that there were annual increases in the plastron length varying from about a half inch to as much as one and a half inches. Adults tend to grow more slowly, and in old age finally remain at a fixed size. A female with a carapace fourteen and a half inches long is considered large, although a sixteen-inch specimen has been reported from Michigan.

——Food and Foes. The slider eats almost anything, showing no special preference for animal or plant food. In its natural surroundings in Illinois it eats tadpoles, mollusks, crayfish, insect larvae, as well as small fish. In captivity it will take almost any food offered to it, including vegetables, fruits, and water plants. In Texas a naturalist fed captives on a diet of meat, grasshoppers, and fish.

In the northern part of its range, the slider has few natural enemies once it has reached the adult stage. But along the Gulf Coast the alligator and the giant gar fish take a significant toll. Cagle states that crows sometimes destroy numbers of turtles when the turtles first emerge from hibernation. In Illinois he frightened crows away from sluggish turtles lying on the bank of a stream, and found that some had been turned on their backs by the wily birds. The crows had pecked a hole into the body cavity just in front of the hind legs, the vulnerable spot on most turtles.

During the winter in Illinois Cagle found a few turtles with their shells gnawed by muskrats. Both mink and otter capture and devour a few, and Cagle says that raccoons have been seen ripping the eggs from a female slider seeking a nesting site. Fishermen in some areas destroy these turtles in the mistaken belief that they are harmful to fish, although it is doubtful whether any game fish are eaten in sizable quantities by the slider.

As so often proves to be the case with other animals, man is probably this turtle's greatest enemy. Countless thousands enter the novelty trade, as mentioned above, to be sold as pets. Many hatchlings

are disfigured with paint before they reach the market. Such unfortunate turtles inevitably become malformed because the paint, unless it is removed, interferes with their growth.

In Tennessee thousands of eggs are dug up each year to be sold as fish bait. Skunks, raccoons and snakes also take a tremendous toll of eggs. Cagle estimates that hardly one egg out of ten survives these raids, especially when nests are concentrated in one area. On a single bank where he counted more than five hundred nests, intensive search revealed only one nest that was still intact.

Obviously the odds in favor of any individual egg's hatching and producing a turtle that is to live until it reaches maturity are exceedingly small. Were it not for the large number of eggs produced, and the great age attained by a few sliders, their numbers would undoubtedly be considerably reduced. No one knows how long these turtles live, but Cagle suggests that a female fortunate enough to escape its enemies might well continue to lay eggs over a period of forty to fifty years.

——SLIDERS AS PETS. Sliders are able to remain active between temperatures of 60° to 95° Fahrenheit, but they probably prefer temperatures between 75° and 80°. Pets can be kept at such temperatures in an aquarium, where some object should be provided to allow them to come out of the water. Unless turtles have sunlight for basking, however, they do not thrive. Chopped meat, fish, earthworms, or tender, fresh vegetables will serve as food. Cod-liver oil smeared on the meat before it is offered will offset deficiencies in the diet, and possibly counteract the lack of sunlight from which turtles kept in urban apartments often suffer. The commercial preparations sold as "ant eggs" do not provide a suitable diet for turtles, despite the claims on the label.

——THE SLIDER'S RELATIVES. The slider has several close relatives that differ from it in coloration and probably in habits. The eastern race or subspecies is known as the Yellow-bellied Turtle, *Pseudemys scripta scripta*. It inhabits streams and ponds along the Atlantic Coast of the United States from North Carolina to northern Florida, and westward along the Gulf Coast to eastern Louisiana, where it gradually merges with the slider. The yellow-bellied turtle has a yellow blotch, instead of the red streak, behind its eyes. If one were to collect turtles along this coast, capturing some in every river he encountered, he would discover that some turtles in western Florida

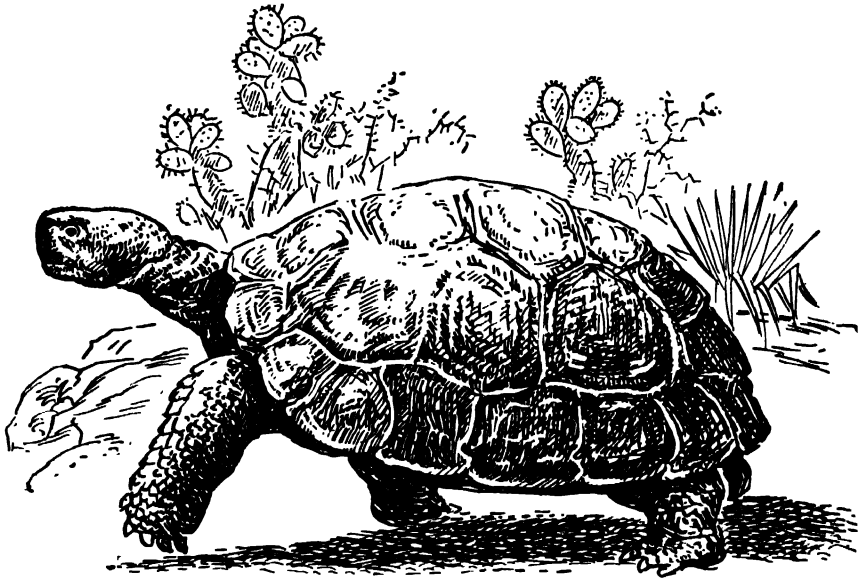
were intermediate between sliders and yellow-bellied turtles, with characteristics of each.

Farther west, the slider gives way to a whole series of populations that range down the east coast of Mexico and on through Central America to Panama. Another series of populations inhabits the rivers on the west coast of Mexico, ranging as far north as Sonora. One branch of the same stock crossed the Gulf of California to reach the southern end of the peninsula of Lower California. The turtles in each area differ slightly from those in nearby regions. Yet the differences are sometimes so slight that turtles from one area might well interbreed with those on either side of it. Thus they are all called subspecies of a single wide-ranging species, which bears the name of the first one described. In this instance it happens to be *scripta* of the Atlantic Coast.

The Giant Tortoise, *Testudo elephantopus.* The tortoises include some of the bulkiest of the land-dwelling reptiles that still survive. Among the more famous are those inhabiting the Galápagos Islands off the coast of Ecuador. Properly speaking, *galápago* is the Spanish term for a fresh-water turtle, whereas the giant tortoises are land animals. Whatever the Spaniards may have assumed, their intention was to name the islands for the great land-dwelling chelonians. ("Chelonian," from the Greek, is a general term for tortoises or turtles.) As the tortoises could be kept alive, unfed and packed in the ship's hold, they provided unsurpassed supplies of fresh meat for the early buccaneers. Later the whalers who visited the Galápagos region came to rely upon the tortoises for similar purposes, carrying them off by the hundreds.

——Where Giant Tortoises Are Found. In past ages some land-dwelling turtles inhabiting continental mainlands grew to colossal dimensions. A prehistoric one from India was named *Colossochelys* and not without reason. Yet structurally it was little different from present-day giants. But within historic times most of the truly large tortoises have lived on islands. The islands in the Indian Ocean, notably the Seychelles, supported elephantine tortoises at least four feet long. No species, however, was much more spectacular than that living in the Galápagos. There are no reliable records of maximum weights for tortoises from these islands, but it is reasonably certain that some of them weighed upward of five hundred pounds.

We do not know how their ancestors reached the islands, which were never connected to the mainland of South America. Naturalists assume that the ancestral tortoise must have crossed the sea in some accidental manner, possibly clinging to driftwood carried out from a river mouth. Tortoises can float and survive for long periods in sea water. A relatively large tortoise, not too distantly related to the one on the Galápagos, survives on the South American mainland. The island form is certainly derived from the same stock.



THE GALÁPAGOS TURTLE—ISLAND GIANT

In past ages, some turtles grew to spectacular sizes in the relative security of island existence. One of the most remarkable of these island turtles is the Galápagos tortoise, weighing in the neighborhood of five hundred pounds. For much of their food these huge creatures depend on the sharp-spined cactus, without suffering any ill effects.

In whatever way the ancestral tortoise reached the Galápagos Islands, it also managed to spread throughout the archipelago. Those on individual islands, or in isolated parts of some of the larger islands, developed their own peculiarities. At one time naturalists recognized as many as sixteen species. It is now conceded by more enlightened naturalists that all of these are races of a single species. The juveniles are very similar in appearance, regardless of which population they

represent. Moreover, the adults are so variable in shape and proportions that only average differences serve to distinguish them. If there were no natural barriers between populations it is probable that all of them would interbreed.

——THE LIFE OF THE GALÁPAGOS TORTOISE. Very little is known about the life history of the Galápagos tortoise. Years ago, Samuel Garman reported that a female he examined contained only two eggs about ready to be laid. These he described as about the size of a "one pound shot" although one weighed six ounces. They are white-shelled, spherical, and about two and a half inches in diameter. It is probable that the larger females lay more than two eggs.

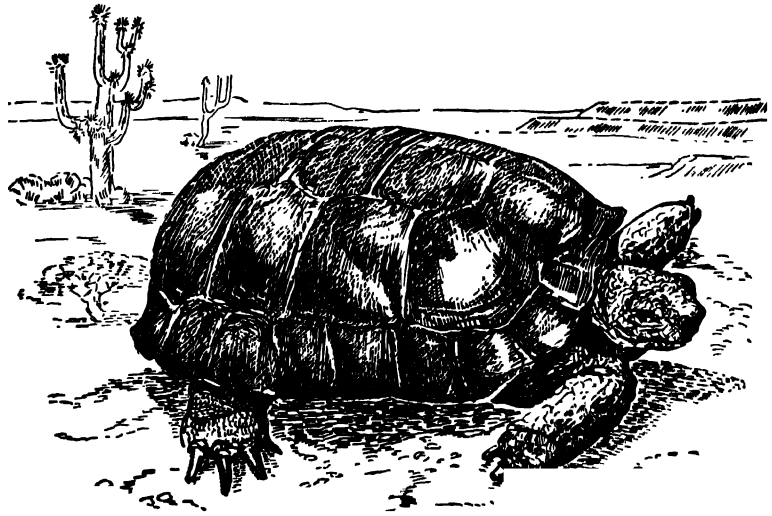
In their isolated habitats the giant tortoises apparently fill the niche occupied by the larger vegetarian mammals in continental regions. On the Galápagos Islands tortoises eat grass as well as the sharp-spined cactus—not only the fruits and blossoms, but also the succulent stems. Observers have marveled that such soft-tongued creatures as tortoises could devour cactus. However, Edmund Heller tells of a specimen that he found with the palate and throat bristling with cactus spines, which had caused no apparent suffering.

Soon after the rainy season the great lumbering reptiles with their elephantine feet descend the mountainous slopes of the islands to feed on the grass-covered flats. After the grass withers during the dry season, they again ascend the slopes to live in the moist meadows. At such times, in the past, they used to congregate in some numbers in the vicinity of springs, although they never voluntarily entered the water.

——ENEMIES OF THE GIANT TORTOISE. Unfortunately the advent of man, who brought cats, dogs, pigs and the inevitable rats with him, has spelled disaster for the Galápagos tortoise. Pigs, and probably the rats and dogs as well, dig up the eggs and devour them. Hundreds of tortoises were killed for the oil that could be rendered from their fatty tissues. In some of the smaller islands man has already exterminated the tortoises. Even on Albemarle, the largest of the Galápagos Islands, they have become increasingly difficult to find. At present there are a number alive in the zoological gardens of the United States and Europe. Each year sees their numbers dwindle. No one has succeeded in breeding them in captivity, and a few more decades will probably bring about their extinction—due largely to the thoughtlessness of man.

The Desert Tortoise, *Gopherus agassizi.* Like other land-dwelling chelonians, the desert tortoise is a vegetarian. Its food consists of the tasty herbaceous plants that cover the desert for short intervals at the time of the spring or summer rains. During hot, dry periods some individuals estivate (lie torpid) or seek the seclusion of an underground burrow constructed for the purpose. Others remain abroad, like their Galápagos relatives, feeding on the fruits or stems of cactus.

——WHERE THE DESERT TORTOISE LIVES. Tourists driving across the Mojave Desert in California are sometimes astonished to see fair-sized chelonians plodding across the road. Those more accustomed to seeing turtles basking on logs or on the banks of streams in the humid regions east of the Rocky Mountains, find it difficult to believe that such animals inhabit arid regions, sometimes miles from water.



A TORTOISE OF THE DESERT

A vegetarian like most of its land-dwelling cousins, the desert tortoise feeds on desert plants during the spring and summer rains. During dry spells it either holes up in a burrow and lies torpid, or it sometimes lives on cactus.

Nonetheless, dry regions, often with sparse vegetation, are the only parts of the United States where the desert tortoise lives. Those shipped to zoological gardens in humid portions of the United States usually do not thrive. This tortoise shuns the denser vegetation of the chaparral along the coast of southern California, but captives

sometimes live for years in such coastal cities as Los Angeles and San Diego. Occasional individuals have been known to breed in these metropolitan areas.

At the northern border of their range in southwestern Utah, desert tortoises assemble in some numbers to hibernate in communal dens. Farther south, in Nevada and California, such dens have never been discovered, although winter burrows occupied by single individuals are common enough in some areas. We have no reports of tortoise burrows in the Colorado Desert of Arizona southward to the Río Mayo of Sonora in Mexico, although desert tortoises have been found in a number of localities.

Thus, in a single species we have a north-south trend in habits, which may be modified to fit local conditions. Winters are cold in Utah and the creatures probably could not survive without a deep retreat. In warmer regions to the south the desert tortoise need only cover its body by squeezing into a crevice or under vegetation to withstand the rigors of the milder winters.

——DESERT COURTSHIP. Desert tortoises have a strange courtship, the male approaching the female with neck extended and head bobbing. If the female withdraws her head and limbs, he nips clumsily at the edges of her shell. When competing males appear on the scene a fight usually ensues. Each male, with head withdrawn, faces his opponent, pushing with all his might. With shells engaged, one of the two may resort to a sudden twisting movement, overturning his opponent. The loser can right himself, but meanwhile the victor returns to his courting. More often the smaller of the two males flees, gaining astonishing speed for a tortoise.

The desert tortoise deposits two to six eggs in a hole dug in the sand, usually in June, two or three months after courtship. The eggs are white, an inch and a half in diameter, and nearly spherical, with hard shells. The hatchlings, approximately an inch and a half long, begin to appear in the fall. These are much less commonly found than the adults.

Berlandier's Tortoise, *Gopherus berlandieri.* Only two other tortoises live within the limits of the United States. One of these, much like its desert cousin, is Berlandier's tortoise. It dwells in rather a limited region, from central Texas southward into Nuevo León in Mexico.

During the warmer part of the year anyone making the trip through the arid region between San Antonio, Texas, and Monterrey in Mexico, is almost certain to see one or more individuals along the roadside.

Berlandier's tortoise tends to have a shell that is more dome-shaped than the flattened elongated one of its western relative. The habits of Berlandier's tortoise are much like those of the desert tortoise in Arizona, although relatively few observations have been reported. John K. Strecker came upon a female in Atascosa County, Texas, that was apparently having difficulties depositing her eggs in the rather hard ground. There were only three eggs, all of them oval in shape rather than spherical like those of the desert tortoise.

The Gopher Tortoise, *Gopherus polyphemus.* The third kind of tortoise inhabits the Gulf Coast, from eastern Texas to southwestern South Carolina, and the drier, sandy areas of Florida. This tortoise is known to Floridians simply as "the gopher." In the Middle West and the West, the same name is applied to rodents, including the Pocket Gopher, which, curiously enough is known in Florida as a "salamander"! Reputedly the use of this wrong name results from a corruption of the term, "sand-mounder"—not an inappropriate one for the cheek-pouched rodent.

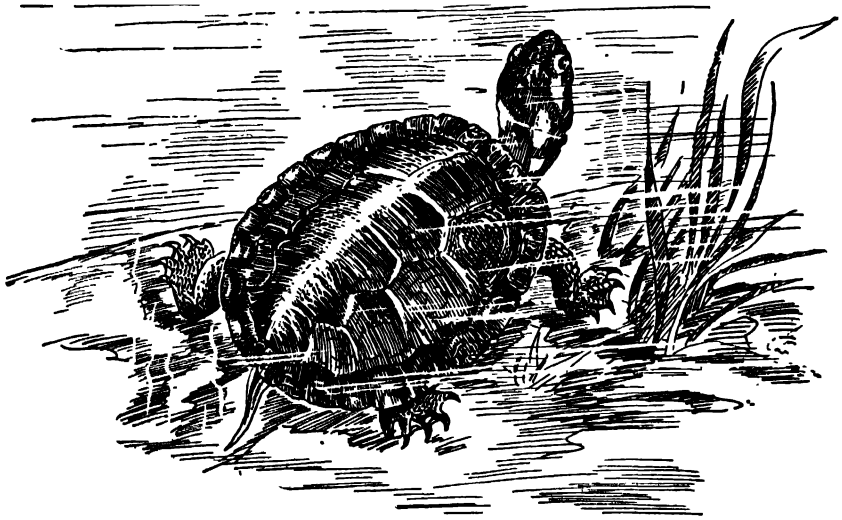
In any event, a "gopher burrow" in Florida refers to the hole dug by the tortoise. The creatures commonly dig them along well-drained sandy ridges or slopes, often in colonies. Usually they excavate the burrow to a depth of several feet, descending ten to more than twenty feet on a slope that varies from fifteen to thirty degrees to the surface.

The same burrow is occupied for years unless it is disturbed, in which case the occupant may move. The reptile comes out to feed upon the grasses and perhaps other succulent vegetation in the vicinity, but returns night after night to the same burrow. Most gopher tortoises are extremely shy. They are alert as they prepare to leave the burrow: the slightest movement in the vicinity will cause them to retreat. When an intruder comes upon a tortoise in the open, however, the gopher merely withdraws its limbs and its head, emitting a low hiss as it does so. Its head is protected by its forelimbs, which fit closely between the front edges of its shell.

The hind feet of the gopher tortoise are proportionately about half the size of those of the desert tortoise, in contrast to its head, which

is relatively larger and more blunt. The gopher tortoise lays its eggs at the front of the burrow, in the pile of earth or sand accumulated during the excavation of its home. The eggs, like those of the desert tortoise, are spherical, and about seven-eighths of an inch in diameter.

The Painted Turtle, *Chrysemys picta.* No account of the common or interesting turtles would be complete without some mention of the painted turtle. This handsome chelonian dwells in the United States and southern Canada, from New England to beyond the Cascade Mountains of Oregon and Washington. There are four recognizable subspecies, one of which, *belli,* has invaded the Rio Grande drainage in New Mexico. It is unknown in several parts of the Southwest, as well as in the peninsular portion of Florida.



THE ATTRACTIVE PAINTED TURTLE

The markings on the painted turtle give it an exceptionally handsome appearance. Its black, red, and yellow stripes and dots stand out effectively against the brownish or slate-colored shell.

The habits of the painted turtle resemble, but are not, of course, identical with, those of the slider. The painted turtle is somewhat smaller—usually under seven inches long in the East, and a bit more than that in the West. It is definitely a water dweller and is commonly seen basking on logs or limbs overhanging pools or streams. But it is impossible to approach without causing it to scuttle into the water.

Observers have reported overland migrations, but these do not seem to be related to the breeding cycle.

Few turtles are quite so attractively marked. The large plates of the upper part of its shell are brownish or slate colored, with yellowish edges. The marginal plates, however, are ornamented with red stripes or spots. The underside of its shell is uniformly yellow in the eastern populations, except for the lower surfaces of the marginal plates. These are bright red, with black and yellowish markings. Its head is blackish, with two pairs of large yellow spots behind its eyes. Its throat is marked with yellow stripes that change to red farther back on its neck, and there are red stripes on its forelimbs and tail. Very young specimens have a yellow stripe down the center of the shell. Individuals in the West often have yellowish instead of red markings, and the underside of the shell is ornamented with a complicated pattern of black lines.

Other Common American Turtles. Other turtles that are relatively abundant in the eastern part of the United States must be mentioned. One of these, the Spotted Turtle, *Clemmys guttata*, is readily recognized by the yellow dots on a black ground color. This is one of the smaller turtles, with a smooth shell length rarely exceeding four and one-half inches. It lives in ponds, ditches, and streams having a muddy bottom. Its range extends from southwestern Maine, westward through a portion of Ontario in Canada to Michigan, and southward to northern Georgia. The spotted turtle is largely an insect-eater, although it also consumes worms, snails, slugs, and similar small animals, along with some vegetable matter.

Although related to the water-dwelling spotted turtle, the Wood Turtle, *Clemmys insculpta*, is approximately twice as long and spends much of its time on land. Its shell is rough, with each of the horny shields on the back raised as a sort of flat pyramid, the edges formed of concentric ridges and grooves. Wood turtles are not infrequently seen on highways in wooded areas in New England, where they feed largely on fruits, berries and herbs; but they do not spurn insects, snails, or other small animals. The species occurs as far south as the Virginias.

On the Pacific Coast another relative of the spotted turtle ranges from Baja California in Mexico to Oregon. This is the Pacific Pond Turtle, *Clemmys marmorata*, the only chelonian living in the fresh-

water streams of coastal California. Strangely enough, this rather drab, olive or blackish turtle occasionally turns up on ocean beaches. Although it is a water animal, the Pacific pond turtle is sometimes encountered during its infrequent land migrations. In the water it feeds on insects, but in the upper Sespe River of Ventura County, California, I have watched it devour the plants growing on the bottom of a clear pool.

THE SNAPPING TURTLES

Only two kinds of snapping turtles are now in existence, both of them in the Americas. They belong to the family Chelydridae. Fossils found in Europe indicate that snappers lived on that continent many millions of years ago. Their nearest living relatives are the New World Mud Turtles, *Kinosternon,* and Musk Turtles, *Sternotherus,* both genera of which belong in a separate subfamily.

The Common Snapping Turtle, *Chelydra serpentina.* Few turtles have quite the extensive range of the slider and its relatives. However, the common snapping turtle is found throughout the streams and ponds of most of eastern North America, from Canada to Mexico, with relatives in Florida, Honduras and South America that should doubtless be regarded as subspecies.

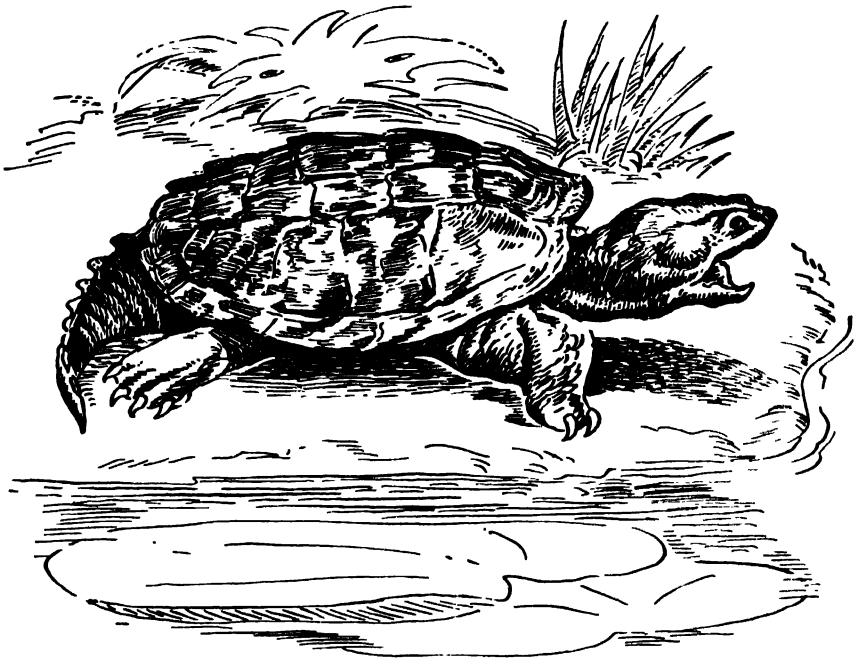
——THE FEROCIOUS SNAPPER. The snapper is a ferocious turtle. When it is encountered on land it holds its ground, thrusting its head forward and biting with such speed that the eye can scarcely follow the movement. At such times its powerful jaws snap with a distinct popping noise if they have not closed on the offender. On occasion its large head may be launched with such force that its entire body is carried off the ground.

Fortunately, perhaps, we rarely encounter snapping turtles on land. In fact, I have seen them come out of the water of their own accord only in Florida following a heavy spring rain. Normally they restrict their activities to permanent bodies of water, ponds, lakes or sluggish streams, usually those which have plenty of vegetation or a muddy bottom.

Snappers have rather large heads and relatively long tails. The underside is poorly protected, the plastron being somewhat diamond-shaped, rounded at the front, but tapering to a sharp point be-

tween the hind legs. A narrow projection from each side connects it with the carapace, which is far more extensively developed. The limbs are stout and powerful, even though the snapper is rather a clumsy swimmer. It spends much of its time feeding on the bottom.

Karl Lagler analyzed the stomach contents of 186 snappers taken in Michigan and found that about one-third of the food consisted of water vegetation. Another third was made up of insects, crayfish, clams, snails, and carrion. Game fishes made up the remaining third. He found little evidence for the widespread belief that they commonly seize game birds.



A FORMIDABLE TURTLE

The general run of turtles are conservative and inoffensive creatures, content to rely on the sturdy shells in which they are encased. Not so the snapping turtle; in biting, it thrusts its head forward with such lightning speed that its body is nearly lifted off the ground.

An adult snapper may weigh as much as twenty to thirty pounds, and there are occasional giants twice this size. The snapper is able to breed at a much smaller size, however, when the shell is no more than a foot long. The eggs are hard-shelled, somewhat smaller than

a ping-pong ball, but quite as spherical and nearly as white when freshly laid. It may deposit as many as thirty eggs in a nest, the cavity of which may be almost any shape.

Owing to their water-dwelling existence, and more especially to their aggressive qualities of self-defense, snappers appear to have relatively few enemies except man. Although the meat is generally considered to be inferior, many snappers are sold as food, particularly in the markets of Philadelphia. Despite its ugly disposition, the snapping turtle's services as a scavenger probably more than offset its obnoxious habits.

The Alligator Snapping Turtle, *Macrochelys temmincki.* No other fresh-water turtle in the United States attains the great size of the alligator snapping turtle. Individuals weighing 219 pounds have been reported. Specimens half this size are powerful enough to carry the weight of a man without exerting any noticeable effort.

The eggs of this great turtle are hard-shelled and spherical, nearly an inch and a half in diameter, and it lays them on the bank not far from the water. The hatchling is much like the adult except that it is covered with wartlike or smaller flattened protuberances. We know very little about its growth, although an alligator snapper that was well grown when received, lived for forty-seven years in the Philadelphia Zoological Garden.

Wickham tells of an alligator snapper thirty-four inches long and weighing fifty pounds that was liberated during July, 1918 in the Blue River of Oklahoma. A copper plate was attached to it in order to insure future recognition. About two months later when the turtle was recaptured there was no appreciable change. The turtle was returned to the river, not to be seen again until July, 1921, when it was found eighteen miles upstream. What its travels may have been in the interim, it is difficult to say.

Captive individuals kept in ponds are not especially active. However, like all turtles, these ponderous reptiles must rise to the surface from time to time in order to breathe. The head, or only the snout, is thrust above the surface, air is exhaled and replaced with fresh air drawn into the lungs. Often the shell becomes covered with green algae, the long filaments of which completely obscure the animal as it lies on the bottom. Man appears to be the only known enemy of the alligator snapper. It is killed by fishermen, who resent its fish-eating

habits. Many are captured alive and sent to market, although its flesh is considered to be only moderately palatable.

——How the Snapping Turtle Gets Its Food. This powerful brute lives in lagoons, swampy lakes, ponds or larger rivers in the Mississippi Valley as well as on the coastal plain from northern Florida to central Texas. The brown hues of its shell blend well with the muddy bottom where it lies motionless, angling for fish with a wormlike decoy that lies along the middle of its tongue.

While lying in wait, the turtle keeps its mouth wide open. The "worm," reddish in color in contrast to the whitish lining of the mouth, is in constant motion. So closely does it resemble a squirming grub that it readily attracts fish. Before the fish can seize the bait, however, the huge jaws clamp down. It may eat other animals, but like the Surinam toad with its fish lure, the alligator snapper is obviously specialized as a fish-eater.

Naturalists described the angling device many years ago, although it was not until recently that anyone saw the turtle actually attract and seize its prey. However, at Silver Springs in Florida, Mr. Ross Allen kept a few individuals alive in tanks where he could watch them feed. A few fish that escaped the jaws were rarely fooled a second time. The turtle caught fair numbers of each batch of fish placed in the tank, despite the wariness of some.

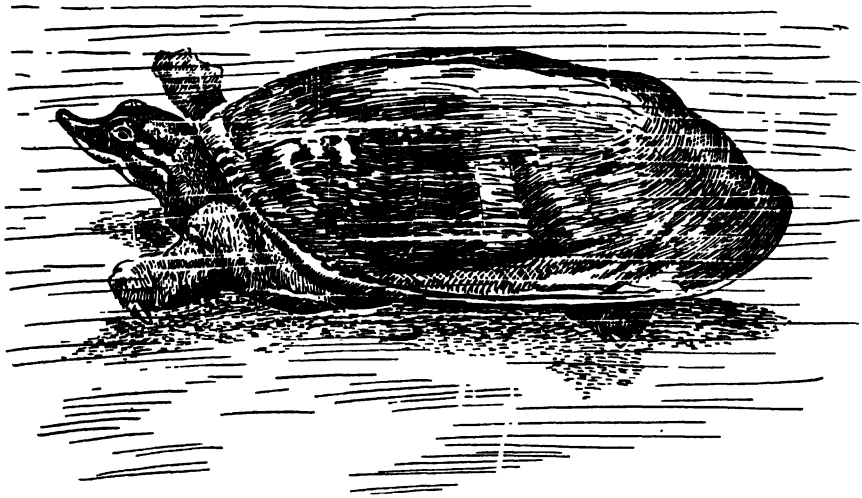
The alligator snapping turtle has no very close relatives that are still living, the common snapper being the nearest. The head of the alligator snapper is proportionately much larger—so large, in fact, that it cannot be completely withdrawn into the shell. Many observers have fancied that the great jaws were capable of severing a wrist or foot: it is commonly stated they will "cut off a length from a broom handle." But such nonsense is probably sheer supposition. Wilfred T. Neill thrust an ordinary lead pencil into the mouth of a fair-sized alligator snapper while we watched at Silver Springs. The pencil was broken but not severed, and it seems doubtful whether even the largest alligator snapper could bite through a broomstick.

The Snapper's Lesser Relatives. Mud Turtles, *Kinosternon,* with four species in the United States and many more in Latin America, are dull-brown creatures that turn up in virtually any sort of stream or pool in the lowlands, from the Atlantic Coast to the Colorado River in California. Like the Musk Turtles, *Sternotherus,* to which they are

related, mud turtles sometimes emit an evil odor that makes them rather disagreeable to handle. Mud turtles can close their shell partially, each bottom lobe being hinged to the immovable bridge. This protective device is crude compared with that of the box turtle, which has a common hinge for the two lobes, so that one lobe swings on the other.

THE SOFT-SHELLED TURTLES

In the majority of turtles the body is protected by a bony shell covered with horny plates. The soft-shelled turtles have evolved in another direction. In most of this family, which has some two dozen members, bony shell has been reduced to a minimum. Their flattened bodies are covered with flexible, leathery shells. Aside from their peculiar body covering, they are readily identified by a long, flexible snout or proboscis.



A TURTLE WITH A FLEXIBLE, LEATHERY SHELL

Circumstances alter cases for the Florida soft-shelled turtle, which flees from attack in the water but hurls itself boldly at its enemies on land. This turtle belongs to a group that differs from all living turtles in having a minimum of hard, bony shell.

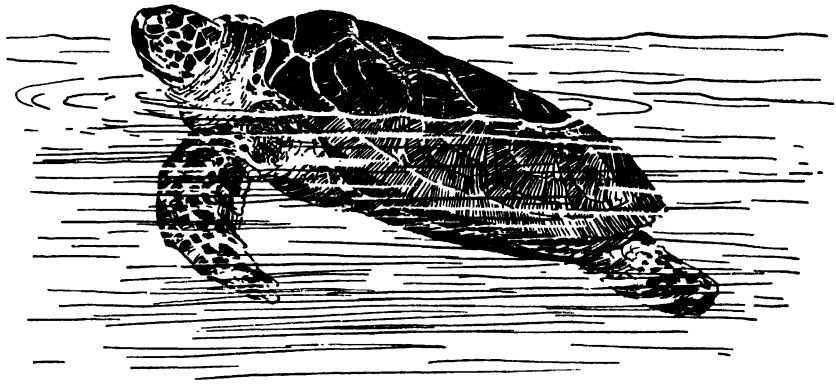
The most ancient remains are from North America, where the family tree extends back well over a hundred million years. For several million years soft-shelled turtles (family Trionychidae) lived in Eu-

rope, where the family is no longer represented. The center of distribution has now shifted to Asia and the East Indies, although there are several species in Africa. Some of the African turtles have flaps that cover the limbs when these are drawn in. This mechanism reminds us of the retractable landing gear on modern airplanes.

Three, or perhaps only two species, with several races—their relationships are not yet clear—inhabit the lakes, ponds, and rivers of the United States from the Colorado River eastward. These turtles are water dwellers, although the Florida Soft-shell, *Trionyx ferox*, occasionally migrates overland. In the water it is a powerful swimmer, retreating swiftly when molested. On land it makes no attempt to flee, but lurches toward the enemy with such speed that it nearly leaves the ground. This behavior is doubtless the basis for the name *ferox*, Latin for "ferocious," an adjective likely to be applied to an animal that defends itself vigorously.

MARINE TURTLES

No account of the turtles would be complete without some mention of those that live in the sea. The half-dozen species recognized belong to two families. The Leatherback Turtle, *Dermochelys coriacea*, is the sole survivor of its group, the family Dermochelyidae. The other turtles living in the oceans are closely enough related to be

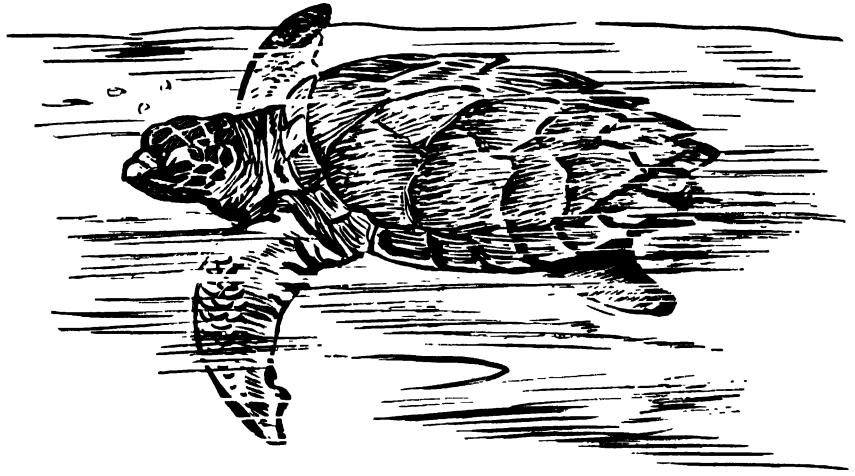


A TURTLE THAT APPEALS TO EPICURES

The tasty flesh of the green turtle gives turtle soup its delicious flavor. There is great variation in size among green turtles, ranging from 850-pounders to comparative midgets weighing about two hundred pounds.

included in the other family, the Cheloniidae. For the most part these turtles are restricted to the warmer oceans. Occasionally they venture as far north as Nova Scotia or the British Channel, presumably carried along in part by the ocean currents.

The six sea-going turtles that visit the shores of the United States are rarely seen outside zoos or aquariums. However, from time to time, fishermen capture individuals of one species or another. Carcasses are occasionally washed up on the beaches. The Green Turtle, *Chelonia mydas,* the flesh of which is greatly esteemed as an ingredient of turtle soup, visits the shores of all continents. Individuals weighing 850 pounds have been reported, although those captured off the coasts of the United States commonly weigh less than two hundred pounds.



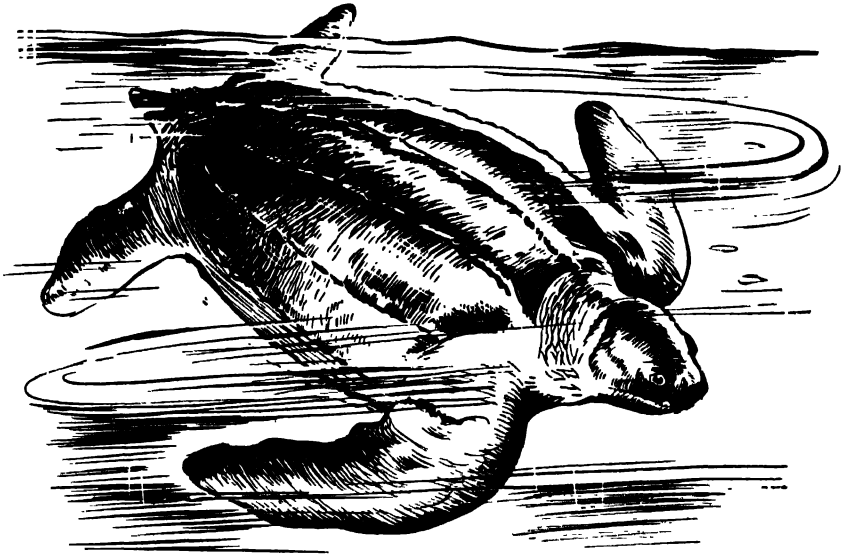
A TURTLE WITH A BEAK LIKE A HAWK'S

Valued as the source of tortoise shell, the hawksbill turtle has a conspicuous beak that reminds us of a hawk. Occasionally we find a hawksbill with a shell a yard long and weighing as much as 160 pounds, but this is not large for a seagoing turtle.

The shell of the green turtle is covered with large shields that do not overlap. Usually it has only a single claw on each of its paddle-shaped limbs. As compared with the Loggerhead Turtle, *Caretta caretta,* and the Ridley, *Lepidochelys kempi,* in the Atlantic, and the Pacific Ridley, *Lepidochelys olivacea,* the head of the green turtle is relatively small. Commonly the loggerheads have two claws on each limb, although the smaller Ridley, *Lepidochelys kempi,* usually has three claws.

The Hawksbill Turtle, *Eretmochelys imbricata,* aside from the more pronounced beak that gives it its name, is readily recognized by the overlapping shingle-like arrangement of the thick plates on its back. These provide the so-called tortoise shell of commerce for bracelets, combs, ornamental pins, and similar articles in Japan and Latin America. Celluloid has largely supplanted tortoise shell in the manufacture of similar items in the United States. The hawksbill is not large for a marine turtle. Exceptional individuals may have a shell a yard long and weigh as much as 160 pounds.

The Leatherback Turtle, *Dermochelys coriacea,* is at the other extreme in size among the turtles that live in the sea. It is likely that this gigantic reptile is more than eight feet long. This was the measurement recorded for a specimen weighing 1,286 pounds; another, taken off Vancouver Island in the Pacific, weighed over three-quarters of a ton. It may well be that some leatherbacks weigh more than a ton, although this remains to be proved. In any event, among living reptiles only the largest crocodiles surpass the leatherback in bulk.



THE LEATHERBACK—A TURTLE COLOSSUS
This huge creature, some eight feet long, weighs well over half a ton. A powerful swimmer, it has a hankering for deep water and comes ashore only to lay its eggs.

The leatherback, as the name implies, does not have the usual horny plates we find in the majority of turtles. The leathery skin, however, covers a bony shell that extends all the way from top to bottom, being made up of hundreds of little bony plates. These are somewhat irregular in shape, and fit together like a mosaic. The limbs, enormously developed as paddle-like flippers, have no claws. Seven prominent ridges extend down the back, presumably serving as stabilizers in lieu of fins.

Though leatherbacks are widely distributed and stray farther north than any other marine turtle, they are not abundant. One has been taken off Nova Scotia, and occasional specimens turn up in the British Channel. One captured off the coast of Ceylon had jellyfish in its stomach. The digestive tract of others that have been examined contained seaweed, or marine algae. This powerful swimmer apparently prefers deep water and ventures onto shore only to lay its eggs. Several clutches, each containing from ninety to 150 eggs, are laid each year. Other marine turtles have similar breeding habits.

THE SIDE-NECKED TURTLES

A side-necked turtle gets its name from the fact that it cannot withdraw its head into its shell. In its efforts to protect its head the turtle can do little more than bend its neck to one side of its shell, holding its head flush against the overhanging edges of the shell. Side-necked turtles (family Chelyidae) live only in South America, Australia and New Guinea, where some kinds are abundant. The one most commonly exhibited in zoological gardens is the South American matamatá.

The Matamatá, *Chelys fimbriata.* No living turtle is quite so outlandish in appearance as the matamatá, an inhabitant of the rivers of British Guiana and northern Brazil. In the not so distant past, large turtles, *Meiolania,* with goatlike horns, lived on some of the islands off the east coast of Australia. Unfortunately these passed into oblivion, leaving us with little knowledge of them beyond what we can glean from a few fossilized fragments of the skeleton. The matamatá has fared somewhat better, although it does not exist in great numbers. Its home territory is rather remote, but a few specimens are exhibited in zoological gardens.

The nose of the matamatá is a long soft tube with tiny nostrils located at the tip. Its small eyes are placed very near the base of its prolonged snout. Its head and neck are as long as or even longer than the shell. Instead of withdrawing its head, the matamatá curls its long neck to one side under the margin of the carapace.

——How the Matamatá Takes Its Prey. The upper part of the shell is covered with lumpy yellow shields which remind us of those of the alligator snapper. But the matamatá has fringelike extensions of the skin of its thick neck, the sides and underparts of the head. The extensions of the chin and throat, as well as the large ear flaps, are movable at will. The matamatá uses these appendages to attract fish.

A naturalist named Mahler kept some in an aquarium in Germany where he fed them regularly on live fish. He reports that the turtle assumes a lying-in-wait position in the water, following every movement of the prey. It turns its head cautiously and then holds it in one position. Waiting alertly, the matamatá sits motionless except for the movements of the queer appendages on its head. As the inquisitive fish come closer, the turtle's mouth suddenly gapes, its throat expands, and it draws the fish in with the onrushing water. Sometimes it engulfs two fish at the same time, usually head first. Mahler and other observers maintain that a loud sound accompanies the sudden movements of the jaws and neck.

The jaws of the matamatá are astonishingly weak and partly covered with a fleshy, liplike skin. Evidently, therefore, the mouth is not adapted for crushing or tearing the prey. On the other hand, the hyoid bones are greatly enlarged. These bones form the tongue attachment in mammals but in many reptiles they have been modified for special purposes. The whole muscular development attached to these bones is specialized to permit the sudden expansion of the neck. The matamatá, therefore, literally sucks its prey into the throat, along with the water. No other turtle is quite so peculiarly modified in this respect.

Despite such queer modifications in the matamatá, what we have read about the box turtle, slider, snapping turtles, marine turtles and others of this group reinforces the impression of exceptional inflexibility. The turtles present a remarkable contrast to the lizards, which are as versatile and adaptable as the turtle is conservative.

The Lizards

ALTHOUGH the role of the lizards is a relatively minor one in the present-day scheme of things, they are fascinating to study because of the endless variations that have arisen, so that each is equipped for its environment. We think of lizards basking in the sun; yet there are some that live underground, some that live in trees; some that glide in the air, some that swim—and some that run on the surface of water! The chameleon, with its color-changing ability, its eyes that act independently of each other, and its tongue that darts some distance to snatch prey—this creature epitomizes the adaptability of the lizards.

Setting up definitions of the lizards and snakes entails difficulties. We therefore commonly place the two groups as suborders of the Squamata. (The lizards are in the suborder Sauria.) Some snakes have retained vestiges of hip bones and limbs, whereas some lizards have entirely dispensed with them. This makes it difficult to use such structures to distinguish between the two groups.

Even so, we might well consider each as a separate order, were it not for some of the odd "connecting links" that occur among both lizards and snakes. On the whole the evolution of the snakes has been quite separate from that of the lizards, from which they are descended. Each group has branched into several well-defined families. Despite the similarities between a few snakes and lizards, the snakes that one ordinarily sees are easily identified as snakes.

Lizards are descended from the same stock that also led to the dinosaurs, the crocodilians, and the birds. Their prominence in the fossil record began at about the time the dinosaurs were disappearing. Several different family groups, specialized in one way or another, arose from the original lizard stock. One family related to the Monitors, which include the largest lizard now living, invaded

the ocean and preyed upon fish. This group of fish-eaters failed to survive for unknown reasons. Today there are no lizards inhabiting the oceans, although one large iguana enters it to feed on seaweed.

The common kinds of lizard are not vastly different in general appearance from the ancestral reptiles. Like the majority of mammals, including man, most lizards have four limbs, ten fingers and ten toes. But the legs and arms are attached farther out at the sides, so that a lizard can rest its belly on the ground without folding its feet under it as a cat sometimes does, or out to the side the way cows or horses do.

LIZARDS ARE REMARKABLY ADAPTABLE

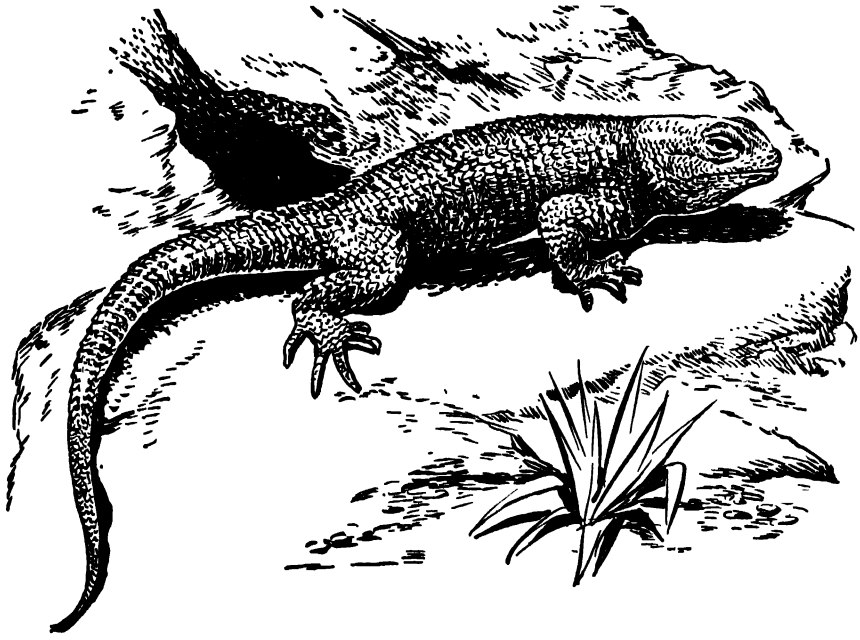
There have been a great many changes in the feet and limbs of lizards to fit them for special ways of life. Those that live on the ground or climb in trees have extremely elongated toes, commonly with the fourth longer than the others. Many lizards, especially Geckos, have patches of greatly broadened scales under portions of the toes to form adhesive pads. These broad scales are bordered along the edges with tiny hairlike extensions that prevent the lizards from slipping when they climb on what appear to the naked eye to be smooth surfaces. Several kinds of lizards that habitually burrow in sand or humus have completely lost their limbs. Others are in intermediate stages, with the fingers and toes reduced in number; and in still others the limbs may be represented by what appear at first glance to be mere flaps of skin.

WHERE LIZARDS LIVE

Some lizards live on the surface of the ground, while others burrow under it. There are those like the large Tropical Iguana, *Iguana iguana,* that live in trees, or some like the American Anole, *Anolis carolinensis,* that dwell in shrubs as well. Still others like the Chuckwalla, *Sauromalus obesus,* prefer rocky places, where they seek shelter in crevices. Those called "Flying Dragons," *Draco,* have false ribs extending beyond the normal body outline. These are connected with thin skin to form "wings." The lizard does not actually fly but glides in somewhat the same manner as the flying squirrel or the flying fish, each of which really prolongs an initial leap. Such animals are gliders,

rather than fliers, but in this limited way the lizards can be said to have invaded the air.

Similarly, no living lizard is truly a water-living animal, even though the Marine Iguana of the Galápagos Islands feeds almost exclusively upon the ocean plants known as marine algae. Others remain in the vicinity of water and do not hesitate to enter it. All lizards can swim after a fashion, and those that frequent stream banks or similar places are commonly excellent swimmers. Some of the larger Monitors, *Varanus,* have been seen swimming in the ocean some distance from land, which may account for their being found on oceanic islands. A small Cuban Lizard, *Deiroptyx,* spends much of its time in the water, and is a sort of counterfeit crocodilian. Its eyes are located on the upper surface of its head so that the reptile can see even when the better part of the body and most of the head are submerged.



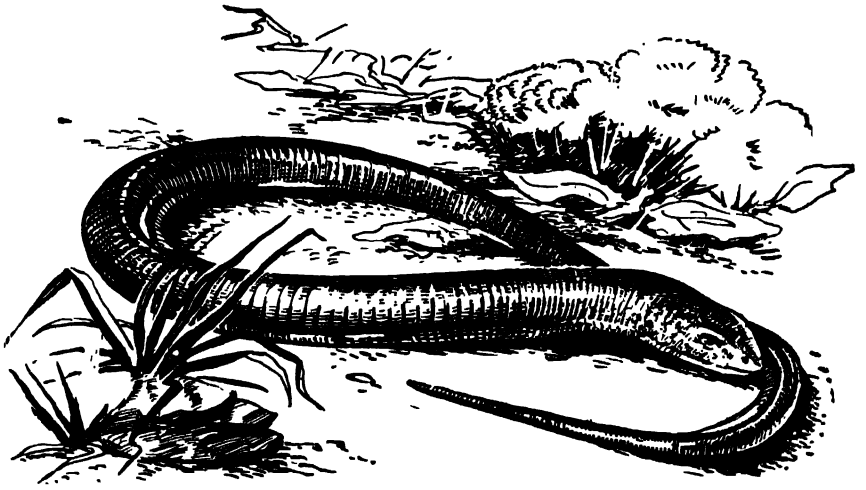
SCALY LIZARD OF THE DESERT

Guardian of the Joshua tree blossoms, the desert scaly lizard frequents the tree yuccas of the southwestern deserts in the United States, preying upon the insects attracted to the creamy white flowers. This large lizard also lives in rocks, abandoned houses, and in woodrat nests; it feeds on ants, beetles, small flowers, and sometimes smaller lizards.

As you might gather from their several adaptations, lizards are a successful group. Today they are represented by nearly three thousand species. They are not quite so widely distributed as snakes, to which they gave rise, probably because most lizards are less tolerant of cold climates. In general, lizards are more abundant in desert regions and in the arid tropics, where they bask in the sun to raise their body temperature.

BURROWING LIZARDS

Not all lizards bask, however. Most members of one large family, the geckos, are active principally at night. Another family, the Amphisbaenidae (sometimes called "Worm Lizards" because many of them superficially resemble earthworms), is composed of burrowers that, with some exceptions, rarely venture to the surface. The eyes of these strange creatures are mere vestiges seen on some as black dots under the skin. Those that live in western Mexico and the southern end of the peninsula of Baja California have retained their front limbs. All other worm lizards have lost them completely.



THE "GLASS SNAKE"—NO SNAKE AT ALL

The so-called "glass snake" is actually a limbless lizard. It differs from snakes in a number of ways—its ability, for example, to grow a new tail if the original one is broken. There is no basis for the popular notion that this lizard can be broken in pieces and that the pieces will thereupon come together again.

These "worm lizards" are largely confined to the tropical and semi-tropical regions. Approximately fifty kinds live in Africa, and nearly as many are known in South America. In the United States there is only one species—confined to Florida. Some naturalists doubt whether these strange animals should be classified as lizards.

The "Blind Worm" of England and other parts of Europe, is neither blind nor actually a worm, being a limbless lizard, *Anguis fragilis* (which means "fragile worm"), with small but quite serviceable eyes. It might, like its American relative, the so-called "Glass Snake," *Ophisaurus ventralis,* be mistaken for a serpent. Both of these lizards retain traces of hip bones, indicating that their ancestors had limbs. They differ from snakes in having movable eyelids, in having the lower jaw bones that are solidly united in front, and in being able to grow new tails when this part of the body is broken off.

THE "GLASS SNAKE" MYTH

The common name "glass snake" is based on the mistaken belief that the body of the limbless lizard can be broken in pieces. Furthermore, if we are to believe a widespread myth, the pieces reunite. Sometimes called the "joint snake" for this reason, this reptile has a tail that when complete is considerably longer than its body. As with the majority of lizards, the tail readily becomes detached or broken if seized by an enemy. This enables the lizard to escape while the animal that intended to prey upon it is distracted by the squirming tail—for the tail may show some movement for several minutes after being severed from the lizard.

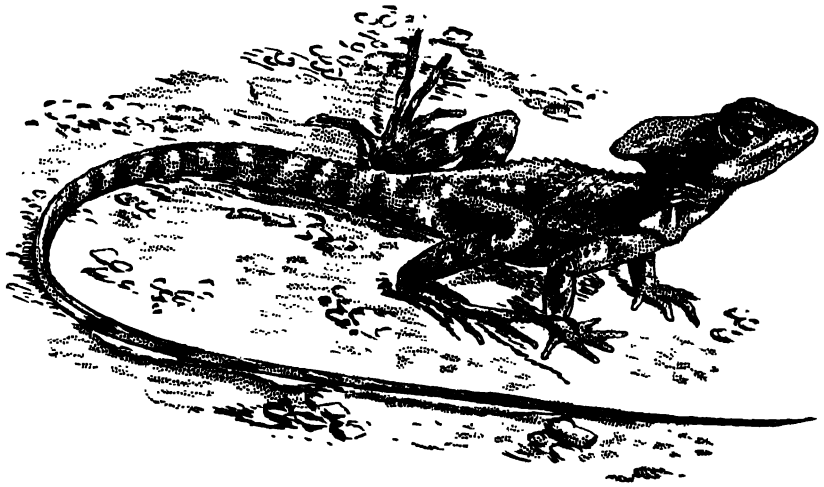
HOW LIZARDS GROW NEW TAILS

All lizards are able to grow a new tail when they lose this extension of the body. However, the new tail does not contain the vertebrae—bones that were a continuation of the backbone in the original tail. The one regrown is supported by a cartilaginous rod, the scales on the surface are commonly irregular and lack the definite arrangements seen on an unbroken tail. The new tail is rarely as long as the first one, and it generally lacks pigments in the skin that form some sort of pattern. The tail can be replaced any number of times, usually in a matter of weeks or months. When the tail is partly fractured, but not actually broken off, a tail will grow from the break, resulting in

the tail's being forked. Ordinarily the plane of fracture is through one of the vertebrae, not between them, as one might expect.

HOW LIZARDS GET THEIR FOOD

The principal food of a good many lizards consists of insects, scorpions, centipedes, or other small creatures they see. The tongue has a muscular stalk that allows it to be thrust out suddenly, the fleshy end being covered with an adhesive saliva that adheres to the insect and pulls it into the lizard's mouth when its tongue is drawn back.



THE BASILISK—NO MYTHOLOGICAL MONSTER

In ancient lore, the basilisk brought instant death to anyone unfortunate enough to behold it. The real basilisk is harmless enough. This lizard runs across the surface of the water, moving its feet so rapidly that it goes some distance before breaking through the surface film. In Mexico it is often called the *paso-rios* or "river-crosser." Basilisks also climb trees, but rarely venture away from streams or lakes. They patrol the banks in search of their insect prey.

Such lizards as the Gila Monster, *Heloderma,* the Skinks, and others having a forked tongue that can be thrust out, rely as much on their sense of smell as upon their sight to detect suitable food. It is interesting to note that only the groups of lizards with such tongues have given rise to true burrowers. We can ascribe this to the fact

that lizards living underground cannot depend on vision and must rely upon their detection of odors that come from suitable food.

The forked tongue is thrust out repeatedly, and when it is withdrawn it carries odorous particles with it. Man, dogs, and similar animals detect odors by carrying them into the nose with the air they breathe. The endings of nerves that lead to the brain are located where the air passes over them. Lizards with forked tongues have similar nerves leading to the roof of the mouth, where the odorous particles carried in by the tongue come in contact with the nerve endings that pick up sensations and carry them to the brain. Thus what are sometimes called the "end organs" of smell are located in the roof of the mouth, but they are dependent upon the tongue.

Taste and smell are closely associated, and taste appears to be better developed in some lizards than in others. Disagreeable food may be rejected, but many lizards will devour any small object resembling an insect if it is moving when seen. Millipedes, which produce an irritating substance on being disturbed, may be taken into the mouth and then hastily pushed out by the tongue or by violent movements of the head.

THE HEARING ABILITY OF LIZARDS

It has been shown that lizards are able to hear reasonably well, although few of them appear to pay much attention to sounds. When he was collecting the Giant Monitor or "Komodo Dragon," *Varanus komodoensis,* for the habitat group in New York's American Museum of Natural History, Mr. W. Douglas Burden set up a blind, like that used by duck hunters, where he could observe these huge lizards without being seen. He watched the cautious reptiles approach the dead pig that he was using for bait, thrusting out their long forked tongue as they came close enough to begin feeding. Whispering at first, Mr. Burden and his companions slowly raised their voices as they watched. The lizards were not disturbed, even when Mr. Burden tried shouting. Seemingly the great monitors paid not the slightest attention to sounds. Nonetheless, they fled when Mr. Burden emerged from his hiding place.

As a result of these observations, Mr. Burden was inclined to believe that the great monitors were possibly deaf, despite their rather well-developed ears. Later, however, Miss Joan Proctor noted the behavior

of one of these monitors kept in the London Zoological Garden. After the animal became used to its surroundings, she found that it would respond to her call and come out from its place of seclusion to be fed, regardless of whether or not it could see her approach. Other more convincing evidence supports the belief that most, if not all, lizards can hear.

VISION IN LIZARDS

Some lizards that live above ground can probably see as well as many mammals. In the American tropics I have seen iguanas flee to safety when they apparently saw me coming toward them from distances of a hundred feet or more. Also experiments have now demonstrated that lizards, and probably all reptiles, can distinguish colors.

The eyes of many lizards have lids that can be closed when they are asleep, or when the eyes require protection. However, many geckos as well as the Night Lizards, *Xantusia*, lack movable eyelids, the eyes being covered with a transparent scale. Such lizards are mostly active at night, and nearly all of them have pupils like those of a cat, expanded and round in the dark, but contracted to mere slits in bright light. Some skinks, the common Brown Skink, *Leiolopisma laterale*, of the eastern United States for example, have a transparent "window" in their lower eyelids.

THE IGUANAS

Iguanas are essentially New World lizards. The larger species are so bizarre in appearance that they are often exhibited in sideshows or in circuses as "Chinese dragons." Despite the fact that members of the family are absent from Old World continents, they are represented in Polynesia and Madagascar. As far as is known, all of them are daytime animals, active at night only when disturbed or routed from their sleep.

The lizards most commonly seen in the United States are likely to belong to the family Iguanidae, named for the lizard known throughout the American tropics as the "iguana." The common name, which is Spanish, but of Indian origin, serves also as the scientific name.

The Iguana, *Iguana iguana,* of the Americas, is the largest member of its family. In some parts of the tropics it occasionally attains a length, including the long tail, of over six feet. A row of greatly enlarged, hornlike scales down the center of its back continues onto its tail. A large flap of skin, a dewlap suspended from its throat, has a fringe of small scales along its lower edge. On each side of its head, behind this dewlap and below the angle of its mouth, is a large, wartlike structure, conspicuous because of its lustrous-white, waxy appearance. Most of its head, including the dewlap, is bright green, with tinges of blue and brown. Its body, except for the row of spines, is covered with fairly small scales. It may be greenish or brown, with darker bars extending down on the sides.

——IGUANAS ARE AGILE. The sharp, powerful toenails of the iguana equip it for an existence in the larger trees of tropical lowlands. Young individuals are sometimes seen in shrubs, but like their parents they seldom stray far from water. The adults ascend to great heights in enormous trees, commonly selecting those with branches overhanging rivers. In the Jamastran Valley of Honduras I have counted as many as five large iguanas in a single tree.

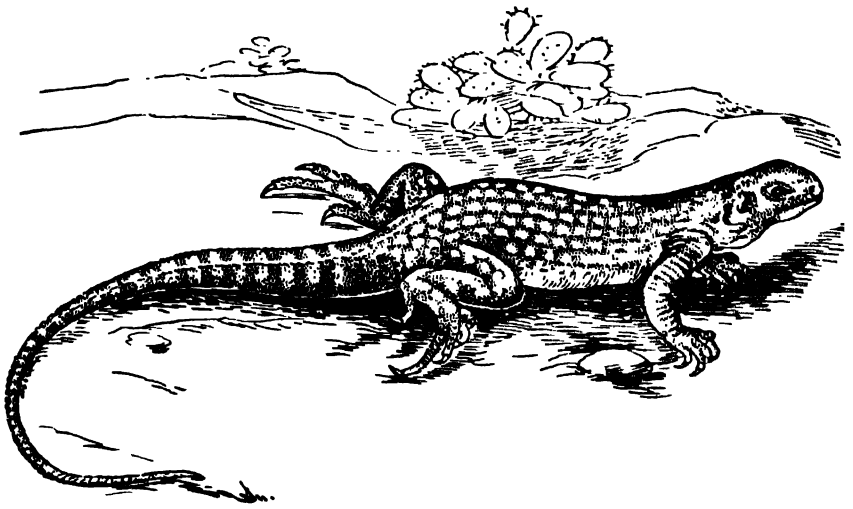
Needless to say, it is not easy to capture these great lizards. When they are pursued by natives climbing the trees, or when wounded by rifle fire, iguanas will drop into the river below, where they swim with agility to the distant bank.

In the Yeguare River Valley of Honduras, I encountered one in the open along the edge of a small swamp that extended between two pastures cleared for cattle grazing. When I first saw the iguana it was basking on the bent trunk of a dead tree that had toppled. As I approached, the lizard abruptly dropped some eight feet to the ground and sped through the grass into a dense undergrowth of the swamp. It produced a loud swishing sound as it pushed its way through the dense vegetation. Apparently it didn't stop until it reached the center of the swamp, for I could hear it over fifty yards away.

Occasionally my companion, Dr. A. F. Carr, and I saw iguanas on the ground along the banks of the river below this swamp; but more often we observed them in the branches of the gigantic fig and ceiba trees so characteristic of the American tropics.

——THE IGUANA AS A DELICACY. Throughout their vast range, from the tropical lowlands of Mexico to the Brazilian rain-forests, iguanas are considered an edible delicacy. Their flesh is white and

tender, not unlike that of frog's legs, and quite as tasty. In Honduras the natives prefer to roast or to bake females containing eggs. They leave the eggs inside and eat them with the flesh.



A LIZARD WITH A BODY TEMPERATURE OF 110° FAHRENHEIT

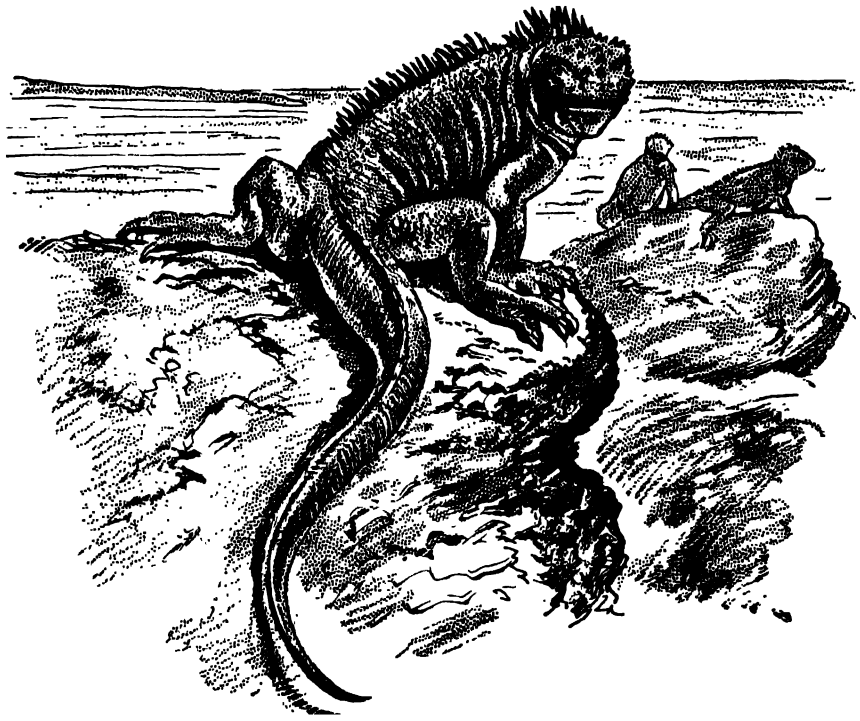
An inhabitant of the hottest, driest deserts in the United States and Mexico, the crested lizard or desert iguana is often abroad with a body temperature of 110° F. Sharing the habitat of the sidewinder or horned rattlesnake, this lizard sometimes succumbs to its deadly neighbor. Though the iguana can readily outdistance the rattlesnake, it is unable to escape the sudden thrust of the sidewinder's fangs if it comes within striking distance.

——How the Iguana Breeds. We know very little about the breeding habits of iguanas, although as many as eighty eggs are sometimes found in a single female. Presumably they lay the eggs in holes dug in the ground, probably with the coming of the rainy season. There is no real summer or winter in tropical regions. Annual breeding cycles are therefore usually keyed to the rainy season, which varies from region to region. But at some time of the year, probably depending upon the onset of the rainy season in each locale, young iguanas appear in great numbers as the eggs hatch. They are almost solid green in color and much less gaudy than the adults.

These juveniles may occasionally eat insects, but the adults confine themselves to a diet of leaves, buds, fruits, and flowers. Both upper and lower jaws are provided with numerous close-set, sharp-edged teeth. These enable iguanas to snip off the vegetation with the efficiency of a pair of stout scissors.

The Marine Iguana, *Amblyrhynchus cristatus.* As the tropical iguana is such an efficient swimmer, it is not so astonishing that a close relative has managed to invade the margin of the ocean. On the isolated, rather barren Galápagos Islands off the west coast of South America, there are two large iguanas. One, a bulky, heavy-bodied, yard-long creature, perhaps heavier than the six-foot iguana of the mainland, lives on land. Despite the sparsity of the vegetation, it feeds on cactus flowers and fruits and other plants. This is the Galápagos Land Iguana, *Conolophus subcristatus.* The other is a slightly less bulky creature, of more or less the same proportions as its mainland relative. This is the marine iguana. It lives only along the coast of the islands, swimming offshore to feed on the marine algae or seaweed that grows on the rocky ocean bottom.

This marine iguana does not seem to have had any important



THE MARINE IGUANA—A SEAGOING LIZARD

About a yard long and quite bulky, the marine iguana lives along the coast of the Galápagos Islands. It feeds offshore, mostly on seaweed and other plants in the ocean.

enemies on land until the coming of man and introduced animals. In the sea it possibly falls prey to sharks or other large fishes. At any rate, when the great naturalist Charles Darwin visited the Galápagos Islands in the early part of the nineteenth century, he found that these sea-going lizards were seeking safety on land. They were present in enormous numbers along the rocky beaches, and Darwin readily approached them and picked them up. Those he tossed into the ocean immediately returned to land. The same individual repeatedly sought the shore when it could easily have escaped from Darwin by swimming away to sea.

It would appear to be a far cry from these large iguanas of the tropical regions to the common Fence Lizards, *Sceloporus,* the American Anole, *Anolis,* or the so-called "Horned Toads," *Phrynosoma,* of the United States. Nonetheless these relatively small lizards all belong in the same family with the giant tropical iguanas.

The American Anole, *Anolis carolinensis.* The American anole is often known and sold at circuses as a "chameleon." The name derives from the anole's ability to change color, from green to brown or the reverse, with some intermediate colors. Actually it is not even closely related to the true chameleons of the Old World, some of which are capable of much more extensive color changes.

——The Anole's Throat Fan. Sometimes anoles extend a throat fan. This ornament is not readily visible unless extended. A slender bone in its throat is attached at the front under its chin in such a way that it can be thrust forward by the attached muscles. This carries the skin with it, causing a fanlike extension of the throat, and exposing the skin, which is pink or red. Because of this throat fan, relatives of the American anole in Honduras are called "*pichete de bandera*" in Honduran Spanish. Translated this means "flag lizard," not an inappropriate name.

——Rivalry Among the Male Anoles. In their natural habitat each large male usually patrols a single area, frequently a single shrub or portion of a tree. Females or the young of either sex may enter this territory, but fully grown male intruders are kept out. Should they approach the male in possession, he extends his throat fan and arches his back, in somewhat the same fashion as a cat does when a dog comes near it. Usually the intruder flees; if he does not, a fight may ensue. The lizards bite each other, sometimes falling

from the branch where the combat began. Ordinarily the resident male is the victor, and the intruder flees.

——How the Anole Changes Its Color. The anole is an inhabitant of trees or shrubs in the humid portions of southeastern United States. When first seen it may be either green or brown, depending upon whether it has been in the shade or in direct sunlight. Ordinarily it is pale green when its body is quite warm, or when the animal has been in the dark. When exposed to bright light, or when its body temperature is low, it is usually brown. It may or may not match the color of its surroundings. Green lizards will be found on brown branches, or a brown lizard may be sitting on a green leaf.

What brings these color changes about is the movement of black pigment in some of the cells of its skin. When these cells expand they partly cover other cells and produce the brown coloration. But when the black cells contract to tiny dots that can be seen only by using a microscope, light is reflected from the other cells. The animal is then green. A tiny gland at the base of the brain produces a hormone that is carried in the blood. This substance controls the movements of the black cells. If the gland is removed—and this can be done by means of a rather difficult operation—the animal remains pale green. It is no longer able to expand the black pigment cells and turn brown.

——The Anole as a Pet. With proper care, the American anole can be kept as a pet. However, if it is to remain healthy for any length of time, it must be kept at a temperature of about 85° Fahrenheit, or a little lower. It needs moisture, which it likes to lap up from the leaves of plants. Hence these should be provided. In its native surroundings the anole probably relies for water upon the dew that settles on leaves during the night. A glass aquarium with a pane of glass over the top makes a good cage. The glass cover will make it possible to keep the air moist if some water is sprinkled in the cage every day. Lizards use so little oxygen that it should not be necessary to remove the cover more than once a day.

When the anole is in the glass cage it is possible to observe some of the interesting habits of this "false chameleon." It will eat insects, but these must be alive and moving or the lizard will not find them. In addition to claws, the anole has adhesive plates under its toes. These enable the lizards to crawl or climb over smooth surfaces, even the glass sides of its cage.

Horned Lizards, *Phrynosoma.* The horned lizards or "horned toads" as they are commonly called, are distantly related to the anoles, which belong to a separate branch of the iguana family. Most other members live in trees or shrubs, or at least climb them occasionally. But horned lizards live entirely on the ground, where their flattened bodies blend with their surroundings and make them extraordinarily difficult to see.

——How Horned Lizards Are Protected by Their Color. Horned lizards found on red soil tend to be reddish, or when found on gray soil they are quite gray. There is always some sort of pattern consisting of blotches in pairs down the center of the back. This pattern may hardly be noticeable if the lizard is found on fine-grained sand. Or it may be very distinct if the lizard lives in regions where the ground is strewn with pebbles. In other words, no matter where these lizards live they tend to have the kind of pattern that renders them least noticeable—the one that makes it most difficult for their enemies to find them. Moreover, the body of the horned lizard is so constructed that it casts no telltale shadow when the reptile is sitting.

——Where Horned Lizards Are Found. There are a dozen different kinds of horned lizards. One or more of these is found throughout most of the United States from Kansas and Nebraska westward to the Pacific Coast. They also range from Canada southward to the western side of the Isthmus of Tehuantepec in Mexico, the habitat of the largest of them all. They live in deserts, in prairies, plateaus, and mountains. I have found one kind at elevations of 10,500 feet in the San Francisco Mountains of Arizona, and another below sea level in the dunes near Salton Sea in California.

——Horned Lizards Live Mostly on Ants. Wherever the horned lizards live their food consists almost entirely of ants. Occasionally they devour small beetles or other small insects. A captive specimen of mine once ate a small garter snake. But they definitely prefer ants under normal conditions, although in captivity they will not always eat them. Some of the larger kinds have been observed sitting in front of beehives, devouring the bees as they come out.

Horned "toads" are not related to true toads, *Bufo,* which, of course, are amphibians. But they do resemble true toads somewhat in their manner of feeding. When an ant crawls close enough to attract the horned lizard's attention, the reptile moves up swiftly and then pauses,

its eyes following every movement of the insect. Suddenly the lizard extends its tongue and snaps it back immediately with the insect adhering to its sticky tip. The whole movement is so swift that the insect appears to vanish abruptly, even though swallowing movements of the lizard clearly indicate what has happened. The lizard picks up larger insects in its jaws and sometimes rubs them violently on the sand before it takes them into its mouth.

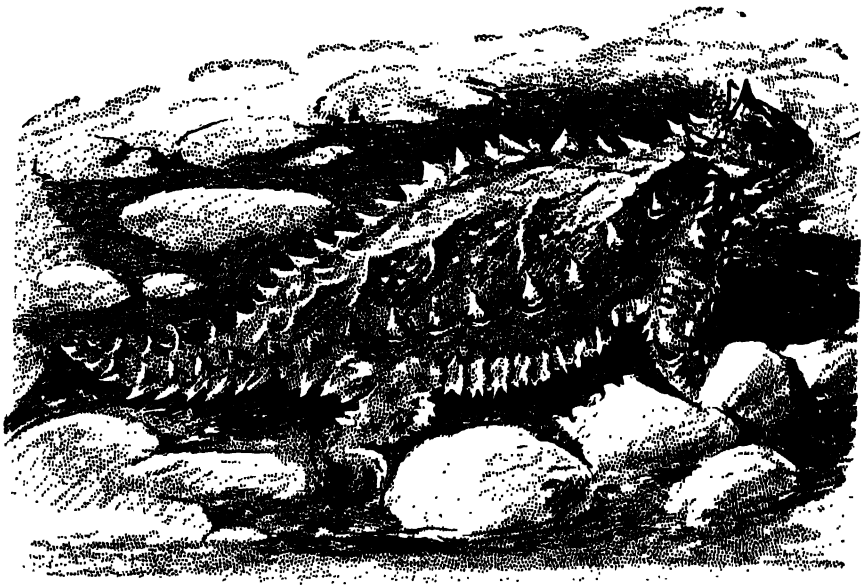
——THE HORNED LIZARD'S SCALY SKIN. The skin of the horned lizard is mostly covered with small scales, with larger ones projecting at intervals. Often there is a fringe of enlarged scales or spines around the edge of its flattened body. There are also enlarged scales along the edge of its lower jaw as well. However, it is the scale-covered, horn-like structures which adorn the back of its head that give it the name "horned lizard." These "horns" are more pronounced in some species than in others. In general they are longer in the kinds of lizards that live in desert regions, and shorter in those of the plateaus, mountains, and prairies.

Aside from obscuring the body outline, thus making the animal more difficult to see, these horns and enlarged scales also serve as weapons of defense. Snakes are loath to attack horned lizards, although some of them do. But even while being eaten the horned lizard is sometimes able to retaliate. By twisting its head from side to side as it is being swallowed, it occasionally manages to puncture the neck of its captor. Dead snakes have been found with the lizard's horns projecting from the neck. Obviously the lizard has not saved its own life, but other members of its kind may be saved as the same snake can never prey upon them!

——BLOOD SQUIRTING. Horned lizards have another peculiarity that I first observed when, as an eight-year-old boy, I found a horned toad in Colorado and placed it on my white shirt. Looking down a few minutes later, I was startled to see a rather sizable blotch of blood on my shirt. Noting that one of the lizard's eyes was bloody, I suspected that the "toad" had squirted blood on me. Later I observed this peculiar behavior in many other kinds of horned lizard.

However, only exceptional individuals spurt blood, usually immediately after capture. It is unusual for the captive to repeat the performance later on, as happened in the following case. In the company of an old Zapotec Indian, who was helping me collect specimens, I found one of the Giant Horned Toads, *Phrynosoma asio*, near the

Mexican city of Tehuantepec. Shortly after I picked it up I saw a fine jet of blood come out of one eye. My Indian companion told me that in Spanish it was called "the lizard that cries blood," apparently in the belief that the bloody "tears" resulted from the lizard's weeping because it had been captured!



THE GIANT HORNED TOAD IS A LIZARD

The horned lizard is commonly (and confusingly) known as the "giant horned toad." It lives on the ground, not in trees, and it benefits from protective coloration. The scaly "horns" at the back of its head generally discourage snakes from attacking it.

Later I showed this same horned lizard to Mexicans farther north. They had never seen such a large one, and always marveled at its size. To add to their interest, the poor lizard squirted blood from one eye virtually every time I took it from the bag to exhibit it. When I finally reached Palm Springs in California and showed the specimen to my brother, the lizard sent a jet of blood from each eye, some of the blood landing fully eight feet away.

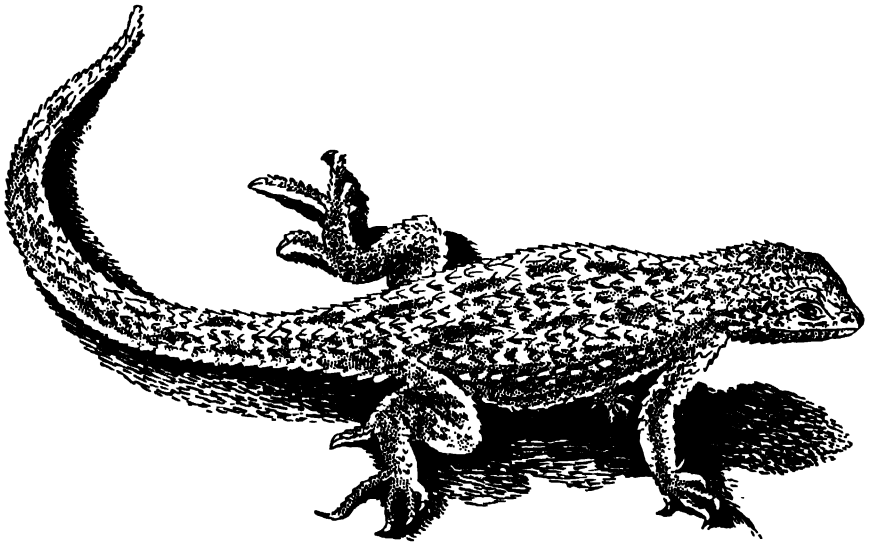
——How the Horned Lizard Breeds. Most horned lizards that live at lower elevations lay eggs, but the kind that dwells on the plateau of Arizona retains its eggs within its body until they are ready to hatch. Near the town of Flagstaff, I caught a very large female one summer and mailed her to Dr. L. M. Klauber, the Curator of Reptiles in the

San Diego Zoological Garden. He sent me word later that the lizard had given birth to twenty-eight young while it was en route!

Horned lizards that lay eggs dig a hole in the ground where they deposit the eggs, usually in June. The eggs of most species in the United States hatch about seventy to ninety days later, when young horned lizards suddenly become abundant.

Stories of horned lizards being able to live for two or three decades sealed in cornerstones or similar places have no scientific basis. One animal that I accidentally left in a box in a cool basement storeroom was still alive a little more than a year later, but it was so emaciated that I could not save it.

The Scaly Lizards, *Sceloporus.* At one time members of the iguana family lived in many parts of the world. Today they are found outside the Americas only in the Solomon Islands and in Madagascar. But from Canada to Argentina they are the lizards most generally seen. The scaly lizards, the common kinds of which are often called "Fence Lizards," are extremely widespread. One kind or another is found from coast to coast in North America, and from New York to Panama.



THE FENCE LIZARD—AND ITS REPUTATION

Fence lizards have shingle-like scales that overlap. Most male fence lizards have blue patches on the belly or throat. The belief that "blue-bellied lizards are poisonous" is sheer fable. These active little creatures are found in most parts of the United States.

Fence lizards and their kin have rather large scales that overlap like shingles on a roof. However, there is a keel in or near the middle of each scale that extends beyond it as a small spine. Very few of these lizards are brightly colored on top, but the males very commonly have large patches of blue on each side of the belly and sometimes on the throat. The statement that "blue-bellied lizards are poisonous," frequently heard wherever such lizards are found, is little more than a fanciful myth.

Other Relatives of the Iguana. The iguana family has many other interesting members. There is the Chuckwalla, *Sauromalus obesus*, for instance, a rather heavy-bodied lizard rarely as much as a foot and a half long, which lives in rocky locations in the southwestern deserts. For protection it crawls into crevices. If molested, it inflates its lungs, expanding the loose skin on its body against the walls of the crevice, thereby making it impossible for most enemies to remove it.



THE CHUCKWALLA MAKES A VIRTUE OF OBESITY

A rather plump lizard, the chuckwalla is named obesus. Its favorite haunts are rocky parts of the American Southwest, where it can crawl into a crevice at the approach of danger. By inflating its lungs, it expands to crowd against the walls of its refuge, few enemies can pry it loose.

There are four kinds of Fringe-footed Sand Lizards, *Uma notata* and its relatives, in the United States and Mexico, all of them living in desert regions where wind-blown sand forms dunes. Scales extend along each toe forming a sort of fringe that apparently helps these

lizards to run more efficiently over loose sand. The fringed toes are used in much the same way that man uses snowshoes to walk on loose snow. These lizards frequently bury themselves in the sand, and sometimes "swim" for short distances beneath the surface. They have spade-shaped noses, with the lower jaw fitting so snugly into the upper that sand does not penetrate the mouth. The special structure of the nostrils prevents sand from getting into the lungs when these lizards are below the surface.

The Basilisks, *Basiliscus vittatus* and its relatives, are quite as bizarre as any lizard in the Americas. The name is from the Greek word, Basiliskos, meaning a kind of serpent, and was first applied to a creature famed in European mythology. The mythological basilisk, quite unlike the real ones, was a dragon so terrible that its gaze or breath invariably proved fatal to those who had the ill fortune to encounter it.

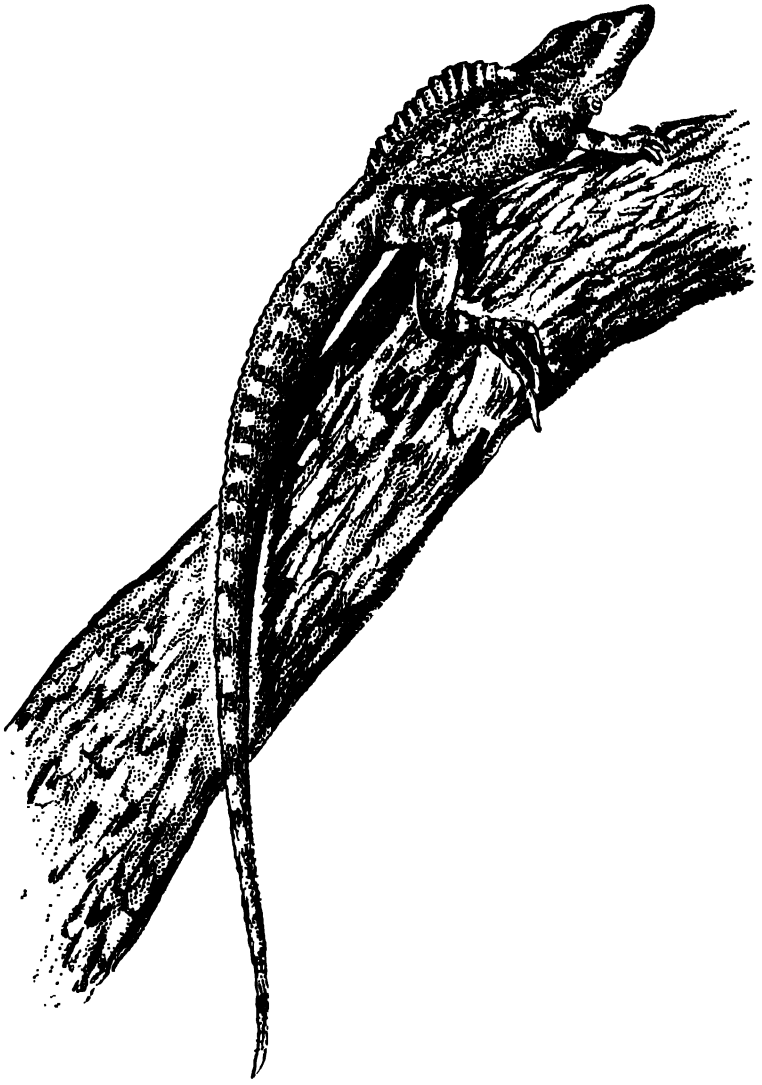
Basilisks, with their long tails, may exceed two feet in length, but they are quite harmless despite their strange appearance. Fully grown males have a thin extension of the skin at the back of the head that is pliable but stiffly supported. This gives the lizard a windswept appearance. The head of this creature looks more like an old-fashioned automobile radiator cap ornament than something belonging to a living animal.

Wherever basilisks are found in Latin America, their textbook name is replaced by such names as *"paso-ríos"* or "river-crossers" in allusion to the reptile's ability to run across the surface of water. In other places they are called *"Jesús Cristo"* lizards for the same reason. Apparently the lizard's ability to travel on water is largely a matter of its moving its feet so rapidly that the water provides enough resistance to support the weight of its relatively light body. If the lizard slows down or pauses, it sinks to the surface of the water and continues on its way by swimming. It does not use its front legs for rapid running, whether on land or water. Not unlike some of the extinct dinosaurs, basilisks and several other lizards, notably Collared Lizards, *Crotaphytus collaris,* run on their hind legs, with the front of the body raised well off the ground and their forelimbs pressed to the sides.

THE BEADED LIZARDS

The only lizards known to have acquired grooved teeth and a specialized saliva or venom, are the beaded lizards (family Heloderma-

tidae). There are only two species, both of them in western North America. The species dwelling in the United States is discussed below. The Mexican species, known to natives as the *"escorpión,"* is the

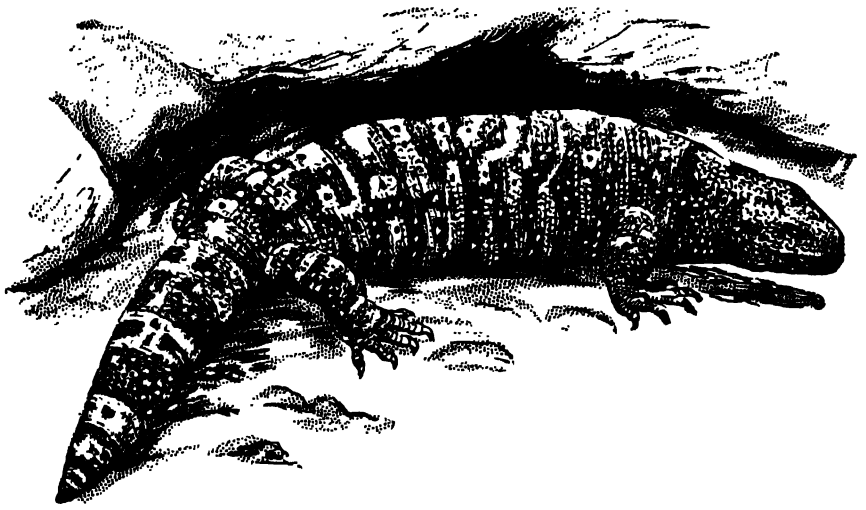


MALE BASILISK

Only the fully grown male basilisk has the high crest on its back. Young basilisks, whether male or female, look pretty much like their mother, but only the male grows up to look like his father. Females not only lack the crest, but never reach the size of the male.

larger of the two. It lives along the Pacific Coast in the Mexican states that extend from Sonora to Chiapas. A lizard, *Lanthanotus,* that lives in Borneo, was said to be related to the beaded lizards, but this has not proved to be so. The Bornean species is not venomous, and turns out to be more closely related to the monitors.

The Gila Monster, *Heloderma suspectum* (Spanish, pronounced "Hee-la"), is the only venomous lizard found in the United States. It gets its name from the fact that white men first came to know this potentially dangerous reptile in the valley of the Gila River of Arizona.



THE GILA MONSTER—REALLY VENOMOUS

Some lizards with a reputation for being able to inject venom are really harmless. The Gila monster, which dwells in the deserts of the American Southwest, has the reputation, and the venom too! However, this "monster" (less than two feet long) bites only on provocation. Its venom, drop for drop, is as potent as that of some rattlesnakes.

The Gila monster is confined to the desert regions of the Southwest, principally Arizona and the adjacent states except California, but including the Mexican state of Sonora. It is a rather large lizard though rarely as much as two feet in total length. Despite its blunt nose, beady black eyes, and stocky build, it is not entirely unattractive-looking. Its skin, filled with tiny round bones that give it the beaded appearance, is brightly marked with black bars or cross-bands on a whitish yellow or pink background.

——THE GILA MONSTER'S VENOM. The Gila monster moves slowly,

but if it is molested it turns and snaps with the speed and ferocity of an angry tomcat seized by the tail. Few people are bitten, however, except those foolish enough to handle captive specimens carelessly. But when the Gila monster does bite, its jaws clamp down with unbelievable force. Relaxing a little and then applying its powerful muscles, it forces its grooved teeth deep into the flesh of its victim. Venom from glands in the lower jaw flows into its mouth and slowly seeps into the grooves of the teeth. Meanwhile the lizard hangs on with all the force it can muster.

Crude as this mechanism is, it does manage to get its venom into the victim. This lizard lives largely upon the eggs of birds that nest on the ground. Upon rare occasions it devours small rabbits or lizards. It is doubtful, however, whether the venom is used as a means of killing such prey. Snakes use their fangs to subdue the animals they intend to eat—the use of their fangs in self-defense is quite incidental. In direct contrast, the Gila monster's venom apparatus serves largely as a protective device, quite unnecessary in the animal's food-getting activities.

THE DRAGON-LIZARDS OR AGAMIDS

The members of the family Agamidae rather resemble the iguanas, from which they may be distinguished by their teeth. In iguanas the teeth are attached to the inner side of the jaw, in contrast to the dragon-lizards, whose teeth are set in sockets on the ridge of each jaw. The Agamidae are widely distributed in the Eastern Hemisphere, including Africa and Australia. The domains of the two families do not overlap, for dragon-lizards are not represented in the Americas, in Madagascar, or in the Polynesian Islands inhabited by iguanids. The dragon-lizards have crests, dewlaps, and other ornamental appendages resembling those found on iguanids. Like the latter, they are essentially daytime creatures in their activities.

The Flying Dragon, *Draco volans.* The Flying Lizards are the only living reptiles that have made any great success in the air. One group of ancient reptiles, the pterosaurs, took to the air on wings and actually flew. Their wings were somewhat batlike, except that the skin forming the wing surface was supported by the arm and a single greatly elongated finger—the fourth. The pterosaurs disappeared mil-

lions of years ago. Meanwhile another group of reptiles had passed through the successive stages that led to the warm-blooded birds, an eminently successful group that now outnumbers the reptiles.

Thus the ancient pterosaurs and the birds perfected their powers of flight. Each in its own way managed to propel itself while in the air.

——THE LIZARD THAT "FLIES." The present-day reptiles in their methods of flight are more like the "flying" fish, which launches itself from the water and sails or glides above the water. The so-called "Flying" Snake, *Chrysopelea,* of Asia merely flattens its body and launches it outward from a tree trunk in a relatively steep glide. *Draco volans,* despite its name, which means "flying dragon," is actually only a glider, too, but a far more efficient one than the flying snake.

The flying dragon is but one of more than three dozen related species that have acquired the "wings" necessary for volplaning from tree to tree. These wings consist of a thin membrane of skin supported by some half-dozen false ribs that extend beyond the normal outline of the body. When this slender lizard rests or climbs about on trees in search of food, these expansions of the skin and ribs can be folded back along the sides of its body. The flying dragon ordinarily pauses with its head uppermost on the trunk of a tree, and at that time it is nearly invisible because its color blends with the bark. But, owing to the bright colors beneath the wings, it has been described as resembling a flashing blue gem as it darts through the air overhead.

All flying lizards are gaudy, colorful creatures when their wings or parachutes are spread. Furthermore, their bizarre appearance is heightened by a long pouch suspended from the throat, as well as by a flap or wattle on each side of the head. The throat pouch, like that of the American Anole, *Anolis,* can be distended or thrust forward, sometimes beyond the front of the head. The wattles too are erectile and can be raised by the male during courtship.

——WHERE THE FLYING LIZARD LIVES. These lizards are especially abundant in coconut and betel palm plantations. They are nimble and active, moving about in a jumpy fashion on the tree trunks where they habitually feed. They are virtually never seen on the ground, although they apparently descend to lay their eggs. Ordinarily after it has searched one tree and devoured all the small spiders, or insects, including ants, moths, flies, and even grasshoppers, the flying dragon suddenly launches itself into the air.

——How the Flying Lizard "Flies." The flying lizard is said to direct its flight with precision, sometimes gliding through the air for a distance of sixty feet before it settles on the trunk of the tree it has chosen as a landing place. The lizard spreads its wings only after it has taken off. It lives almost continuously in the highest treetops, descending somewhat at the end of each glide. Its flight is at a slight angle downward from the horizontal, however, and it tilts sharply upward when it alights. It always lands with its head upward. It prefers vertical trunks as landing fields.

——Courtship and Breeding Among the Flying Lizards. Male and female meet each other with their wattles and throat pouch distended. Dr. Karl P. Schmidt watched the Celebes Flying Lizard, *Draco spilopterus,* and saw the male spreading and folding its parachute, apparently as a courtship display. Dr. Malcolm Smith notes that these lizards are always seen in pairs, hunting in close company. He believes that having once paired, flying lizards remain together throughout the season.

Dr. Schmidt's observations of the Celebes flying lizard, mentioned above, are of such special interest that they merit quotation in greater detail.

"On these days [June 21 and 22] *Draco spilopterus* was abundant in the rather open hardwood forest which clothes the slopes of Lembeh. The longest glide observed was perhaps thirty feet, there being no occasion for longer flights. These lizards glide at a low angle and alight without shock after only a very slight upturn. Mr. Walter A. Weber, the expedition artist, and I were fortunate in witnessing what appeared to be the courtship display of these lizards. A female, with wings folded at her sides, clinging head upward on a tree trunk a dozen feet distant from our station and twenty feet from the ground, was approached from above by a male, who advanced to within a few inches of the female, halted, and went through bobbing motions like those of the American anole, familiar to American herpetologists. As the anterior part of the body was raised, the colored dewlap was distended to its fullest extent, and at the same time the brilliantly colored wings were extended to the greatest possible degree. In this posture the bobbing display was continued for perhaps a minute. At this juncture a second male flew from a tree near us to the tree on which the courtship was in progress, ran up the tree and engaged the first male in combat. This struggle was so violent that both animals fell from the

tree. They disengaged in mid-air, and sailed off to separate trees. The recovery of balance in mid-air and the ability to direct the flight to a suitable landing place is an interesting testimony to the perfection of gliding flight attained by these lizards.



LIZARDS THAT "FLY"

Some lizards are equipped with a thin membrane supported by false ribs jutting out beyond the normal outline of the body. By spreading the membrane, these creatures can glide as much as sixty feet at a time. Flying lizards spend virtually all their life in trees.

"Whether the bobbing motions and display of the colored wing and throat membranes are for the attraction and excitation of the females or solely for sex recognition, it seems clear that the brilliant coloration of the wings is correlated with this secondary use. There is even the interesting possibility that these unique structures originated as a secondary sex character, and that their use in gliding flight is secondary."

Felix Kopstein, whose studies of reptiles in Java are unsurpassed, found two eggs of the flying dragon in his garden during the latter part of July. These were nearly an inch long and covered with a

parchment-like shell. On August 13, the young, two and a half to three inches long, appeared. On October 30 of another year he observed a female lay five eggs that hatched on November 28. Few reptile eggs hatch after so brief an interval unless development is already under way prior to their being laid. Whether the eggs of the flying dragon undergo prior development, remains to be found out.

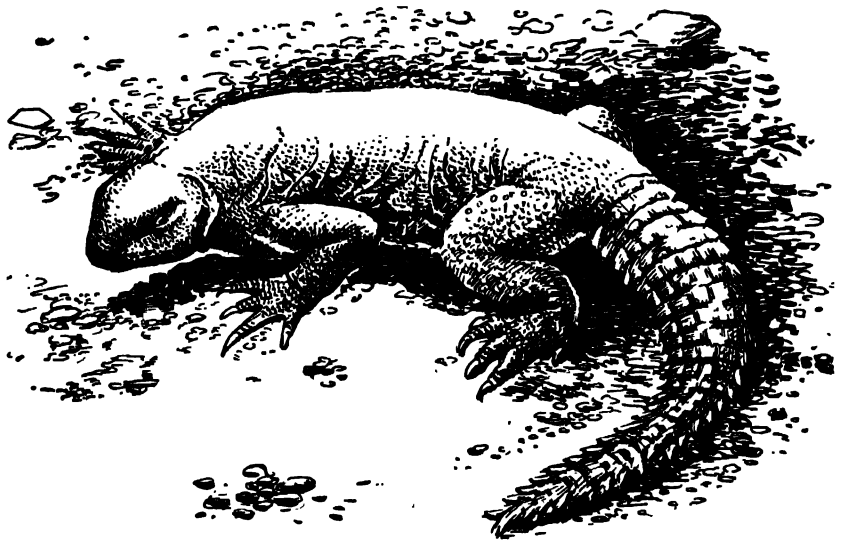
No one has ascertained whether the flying lizard establishes territories and defends them against intruding males. Apparently there is some competition among males, however, for Dr. Smith quotes the statement of Mr. G. F. W. Elwes who saw two of them fighting. While Mr. Elwes watched the combat, one or the other occasionally lost its footing and fell. Its wings were quickly spread, however, and the lizard managed to glide back toward the tree to again hunt up its adversary and renew the fight. A third lizard, presumed to be the female, put its head around the trunk at intervals as though interested in seeing how the fight progressed.

Lizards of the Old World and the New. Flying lizards have a peculiar distribution. One species is found in southern India, but the others all live in the southeastern extremity of Asia, from Assam to the East Indian Archipelago, and the Philippine Islands. No flying lizards have been seen between Central India and the Burmese border—a distance of about a thousand miles.

Some members of the Old World Agamidae family, as we have noted, have a certain amount of resemblance to the New World relatives of the iguanas. Thus, the American Basilisk, *Basiliscus*, has its counterpart in the crested, casque-headed lizard of the Philippines. The chuckwalla of the arid peninsula of Baja California is roughly similar in form and habits to the Spiny-tailed Lizards, *Uromastix*, of desert regions in Asia and Africa. In fact there are many striking parallels, some closer than others, between species in the separate families. Australia's Thorny Devil, *Moloch horridus*, is the counterpart of the American horned lizard.

No lizard in the New World bears even the slightest resemblance to the flying dragon and its close relatives. Some small tree-dwelling lizards, such as the Anoles, *Anolis*, do not fall in a direct line when dropped. The surfaces provided by their feet and bodies may cause them to veer away from the perpendicular to some extent, but this is scarcely gliding in the sense that the dragon performs its aerial ma-

neuvers. The pterosaurs, as we have seen, suffered some sort of evolutionary crack-up. But today the flying lizards are evidently successful—perhaps as much so as the flying fish, the flying squirrels, and the few other animals that use gliding as an efficient means of escaping from their enemies or moving from place to feed.



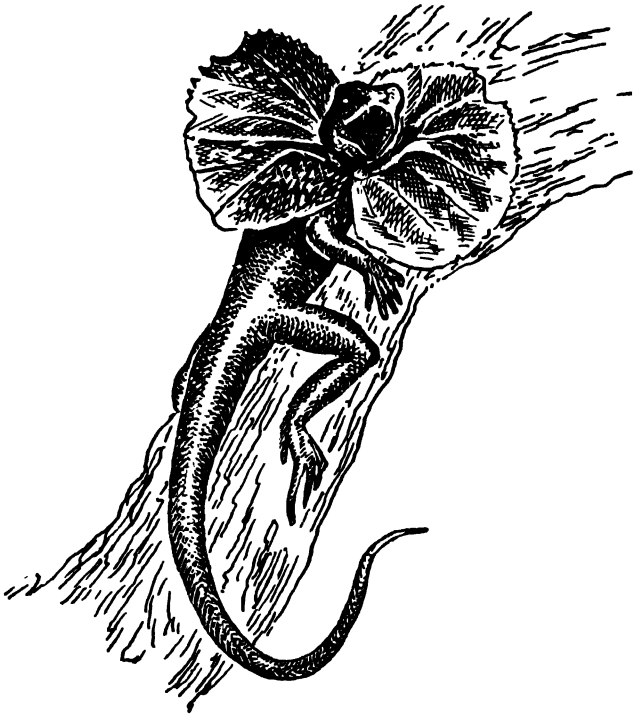
A LIZARD WITH A FORMIDABLE SPIKED TAIL

The spiny mastigure is an Arabian lizard that manages to support itself on vegetation in one of the most barren deserts of the Old World. In fact, it succeeds in attaining a greater size than any other member of the rock lizard family. Its spiny tail, rather like a spiked war club in appearance, is a formidable weapon.

The Frilled Lizard, *Chlamydosaurus kingi.* Frightening devices or "scare organs" have evolved in a number of reptiles, but none is quite so spectacular as the one employed by the frilled lizard. This agamid is an inhabitant of tropical forests in northern Australia and New Guinea, where it feeds on beetles and other insects that frequent the bark of trees. The most remarkable feature of the animal, however, is its large frill—a vast expansion of the skin on each side of the neck. These expansions join across the throat, where they are intimately connected with extensions of the hyoid bones in the throat. Specially modified muscles attached to these bones erect the frill at the same time the mouth opens.

——THE FRILL AS A DEFENSE MECHANISM. Ordinarily, when the liz

ard is foraging on the trunks or the lower limbs of trees, each side of the frill folds back neatly in four pleats on its neck and shoulders. Upon the approach of a threatening assailant, however, the frill is suddenly erected like an umbrella being opened. When at bay, a thirty-inch lizard expands a frill that is nearly ten inches across. The widely gaping mouth, red inside, adds to the animal's formidable appearance. In Australia dogs that have learned to pursue and kill other equally large lizards refuse to come to close quarters with the frilled lizard.



A FRILL WITH DEFENSIVE VALUE

A frill that is no "mere frill" is possessed by the lizard pictured above. This creature has considerable loose skin about its neck. When the frilled lizard opens its mouth, the skin is stretched taut, giving the animal a most frightening appearance.

When running, the frilled lizard uses all four limbs only at the start. As it gains momentum, the reptile raises its body to an erect position and runs on its hind legs. It covers forty or fifty feet at a stretch, coming to a stop sitting high on its haunches. After resting for a mo-

ment, the lizard resumes its running course. Aside from its ability to get about on two legs, and its method of frightening an enemy, the frilled lizard is remarkable in being almost equally at home on the ground or in a tree.

THE TRUE CHAMELEONS

No other family, as a whole, is quite so specialized in one direction as the chameleons. All members of the family possess an extraordinary tongue and amazing modifications of the toes that transform them into grasping mechanisms. None of the chameleons is adapted for rapid movement on land, although the species that lay eggs must descend to the earth to build their nests. Some give birth to fully formed young, quite possibly while clinging to the tree or shrub they live in; the process has never been observed under natural conditions. There is some evidence that the live-bearers give birth to their offspring individually, at delayed intervals, rather than in rapid succession.

The tail, like the feet, is a grasping organ, except in some smaller African species that have been referred to separate genera, *Rhampholeon* and *Brookesia*. Here the tail intensifies the resemblance to a leaf, the outstretched tail serving as the "stem" when the body is viewed in profile. The "casque head" is characteristic, but all sorts of projections from the head, including "horns," crests, prolonged snouts, have evolved in the various species. In the majority of them the body is under four or five inches in length. A few species are relatively huge, with bodies up to a foot long. If the prehensile tail is included, the total length approaches two feet. The chameleons make up the family Chamaeleontidae.

The Common Chameleon, *Chamaeleo chamaeleon.* The chameleon has been aptly characterized as the possessor of "the most amazing tongue in nature." This grotesque reptile is specialized in so many respects, however, that it would be equally valid to single out any of its other remarkable qualities.

The chameleon's fingers and toes are split into opposing bundles, with three on the outer and two on the inner side in the feet, but with the reverse arrangement in the hands. Its eyes are housed in cone-shaped turrets, and each can be focused independently of the other. One eye may be directed upwards, while the other is trained toward the rear. When the creature is in search of food each eye is continually

revolving in all directions. When the animal sights its prey, however, it focuses both eyes upon the object.

——THE CHAMELEON'S AMAZING TONGUE AND HOW IT WORKS. Most chameleons prey upon insects, grasshoppers in particular. So slow and deliberate are the chameleon's movements that it is doubtful whether the victim is aware of its approach. When the lizard is perhaps a foot away, it pauses, watching intently with both eyes as though taking aim. Its mouth opens slowly and the pink, clublike end of its tongue protrudes. Abruptly the insect vanishes from its resting place. It happens so quickly that an observer gets only a fleeting glimpse of the tongue as it shoots out to its full length. An instant later the grasshopper is being crunched between the chameleon's teeth as the lizard prepares to swallow its food.

This astonishing performance is made possible by the unique development of the mechanism that provides for the extension of the tongue. This is a tubular stalk for the club-shaped end with the sticky secretions that ensnare the prey. The tubular portion is drawn back over the tapering end of one of the hyoid bones in the throat. The stalk is made up of a series of circular muscles that can be contracted rapidly, one after the other. As they contract on the slippery end of the bone, the tube, which has been drawn back on the bone like a spring on a stick, is propelled forward. The principle involved is the same as that utilized to eject a fresh watermelon seed from the hand by squeezing it between the thumb and finger. Contraction of other muscles in the chameleon's tongue causes it to be rapidly withdrawn into the mouth, carrying the morsel of food on its adhesive tip.

——HOW THE CHAMELEON CHANGES THE COLOR OF ITS SKIN. People think of the chameleon as being an animal that can change the color of its skin to match any object upon which it is placed. Actually, this queer lizard is able to change its color only from green through yellow to dark gray. Sometimes it may be halfway between any two of these colors. When it is in a dark room with no light whatsoever, it becomes yellow. When it is placed on a dark object in strong light it becomes dark gray. On the other hand, if it is placed on a light background in bright light it becomes yellow. Before you can understand how these changes are brought about, you must know something about the chameleon's skin.

If you look at a slice of this skin under a microscope you can see that, as an outside layer on the body, it is made up of little cells.

These cells look somewhat like a number of grapes of different colors in a layer of pale jello. However, the cells are very much smaller than grapes, so that we cannot see them unless they are greatly magnified by the microscope. Most of these very small cells near the top are yellow in color. Some of the cells in between are black, while others on the bottom of the layer are whitish. These white cells, like mirrors, serve as reflectors. When the chameleon appears to us to be yellow it is because we see only a great number of larger yellow cells. A smaller number of tiny black cells are present, but we do not notice them unless the skin is examined under a microscope.

You will have some idea why the lizard seems to be green to us at the times when these black cells are not expanded or "blown up," if you remember what happens when you write with blue crayon on a piece of paper, and then write over the blue with yellow pencil. Yellow on top of blue looks green to us. This is almost the same thing that happens to the chameleon's skin. The white cells on the bottom of the layer of the chameleon's skin reflect blue light. When this blue light passes through the yellow cells it appears to us to be green light; in other words, the chameleon looks green.

Now what happens if the black cells, those in between the white layer on the bottom and the yellow layer of cells on the top, expand? The cells that appeared under the microscope as black dots now become larger, with fringelike extensions in outline. They fill up the space between the white layer and the yellow layer. Like a black window shade in front of a mirror, they cut off all the blue light that the white cells on the bottom have reflected. As a result the top layer is almost all we see. The chameleon now appears to be a yellow lizard.

But suppose those same little black balloon-like cells, with fingers extending outward from them, continue to expand. They spread outward into the top layer, and begin to surround the yellow cells. Finally we can scarcely see the yellow cells at all. Nearly all we see is the black cells. Then the lizard looks as though it were dark gray or blackish.

——How the Chameleon's Nervous System Produces Color Changes. What makes these black cells grow big or remain small? You have heard about nerves. You know that if you are stuck with a pin on the end of the finger a nerve carries a "message" to your central nervous system. You realize that you have been hurt. You jerk your finger away from the pin. While this is not what happens when

the chameleon's color changes, it will give you some notion of the way in which the nerves carry "messages" to other parts of the body.

In fact, we can think of nerves as electric wires, somewhat like those that lead to an electric light. When you press a button, the light goes on. The chameleon has tiny cells in its skin and eyes, and these cells serve the purpose of press-buttons. When light reflected from a dark object falls on these tiny cells in the eye the effect is much as though someone had pressed a button. Instead of a light turning on, however, the black cells begin to grow larger, like a balloon being inflated. Then, as we have explained above, the chameleon turns blackish in color.

Now suppose we put the chameleon in a dark place, so that no light



THE AMAZINGLY VERSATILE CHAMELEON

This small but adaptable lizard has a host of remarkable qualities. With its swivel eyes it can look in different directions at the same time. To get its food, it uses its long, sticky tongue to good advantage. It is able to grasp objects with its tail. Above all, it is famous for the way it changes color, even though it does not always match its background.

reaches the little "press-buttons" in the skin, or in the eyes. It is as though the electric current had been turned off. The black cells again become small dots. What happens to the chameleon's appearance? Remember, with the black cells now reduced to minute dots, all we see is the yellow cells. The lizard is now yellow.

The situation becomes more complex if we put the lizard in bright light, on a white object where some of the "buttons" (actually receptors) in the skin are "pushed" or stimulated at the same time as those in the eye. Now what happens? The "press-button" cells in the skin start the nerve impulses that make the black cells expand. The lizard for a moment starts to become dark. At the same time, however, the "press-button" cells in the eye are "pushed" and they *stop* the changes that the skin cells (or "press-buttons") have started. Then no message is ever carried to the nerves that control the size of the black cells. The cells therefore remain small, so that we see only the yellow cells. To the unaided eye the chameleon is yellow.

Thus the chameleon with its color changes is comparable to an electric sign that changes color. But instead of wires and light bulbs of different colors, the lizard has minute nerves and tiny colored cells. Instead of a number of press-buttons or switches, such as those that make the lights change in electric signs, there are special cells that serve the same purpose. We might even say that these press-button cells work on the same principle as the "electric eyes" now used for such purposes as opening doors. When the light falling on these "eyes" is interrupted, the doors open. But in the chameleon when light falls on the cells of the skin alone, the black cells start to expand and cover the white reflector cells, so that we see a green chameleon. If the chameleon's skin receives no light the black cells remain tiny black dots, and the chameleon is yellow.

——WHERE CHAMELEONS ARE FOUND. Chameleons are most abundant and widely distributed in Africa and Madagascar, where they live in both trees and shrubs. The "Common Chameleon" is actually no more abundant than many other African species. It merely happens to live in north Africa, Israel, the Arab countries, and some of the islands in the eastern Mediterranean. Consequently, it is the kind most commonly obtained. Of nearly eighty species, only one is found outside the regions mentioned above—in India.

THE MONITORS

During Focene times, some sixty million years ago, the monitors inhabited Wyoming, and doubtless other portions of North America. Today these animals are all confined to the Old World.

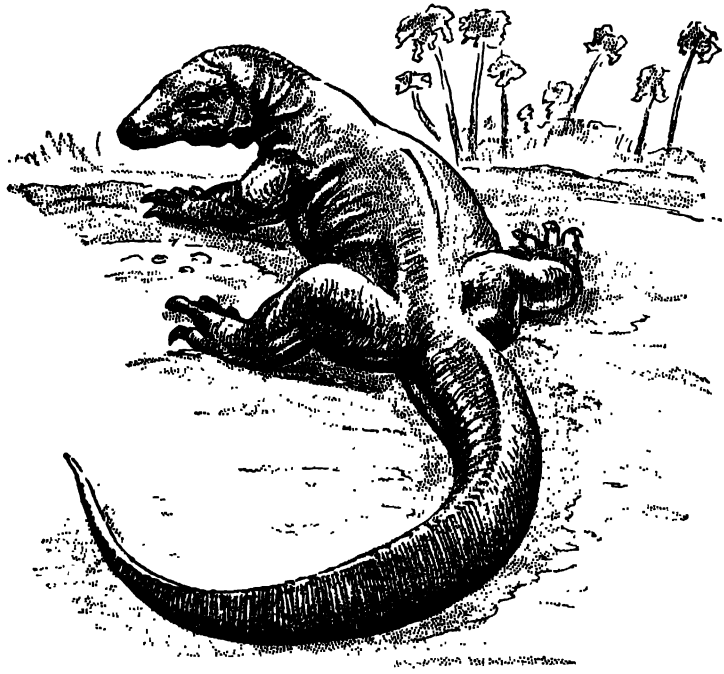
The monitors—they make up the family Varanidae—are agile, active creatures, whether on the ground or in trees, the two habitats most commonly frequented. Despite their well-developed limbs, monitors are quite snakelike in many features of their skeleton, as well as some of the soft tissues. The protrusible (darting) tongue is constantly in motion when the creatures are foraging, and doubtless serves to pick up odorous particles just as it does in the snakes. It is not impossible that the earliest snakes were derived from a burrower that branched off from the ancestral monitor stock. No burrowing monitors, either fossil or recent, have been discovered thus far, however. Should one be found, it would make an ideal ancestor for the snakes—if it were ancient enough.

The Giant Lizard of Komodo, *Varanus komodoensis.* It seems unbelievable that a ponderous creature nearly ten feet long could remain undiscovered until the present century. But that is just what happened in the case of the giant lizard. On the Indonesian islands of Komodo, Padar, Rintja, and Flores it had undoubtedly been known to the natives for centuries. But not until 1912, when a Dutchman, P. A. Ouwens, obtained five specimens, did the largest lizard in existence become known to the scientific world.

We can attribute the tardiness of the discovery of the giant lizard to the relatively recent exploration of the tiny islands between Borneo and Australia. However, the casual visitor might well have missed seeing the "Komodo Dragon," as the creature is sometimes called. Although it dwells in a region of bare rocks and broken ground interspersed with grass, bushes and an occasional palm, the giant lizard is a wary creature. Stalking through the tall grass with the long snakelike protrusible tongue working incessantly, it raises its huge body from time to time to scan the surroundings. Only by concealing himself behind a blind can the prospective observer hope to obtain more than a fleeting glimpse of this huge reptile.

Virtually nothing was known of the reptile's habits until W. Douglas Burden organized an expedition to study the "Dragon Lizard" in

1926. Mr. Burden found that the carcasses of wild hogs made suitable bait and he managed to attract a number of the reptiles near the blind he had set up in advance. Hidden from the lizards, he obtained motion pictures as he watched them feed.



THE KOMODO DRAGON—GIANT OF THE LIZARD CLAN

Though the Komodo dragon of Indonesia is a large and formidable creature, almost ten feet long, it was unknown to science until the present century. Students of fossil remains tell us that sixty million years ago relatives of these creatures roamed over Wyoming.

——THE GIANT LIZARD IS A VORACIOUS EATER. Clawing and ripping with their sharp teeth, the voracious lizards ripped off great chunks of the foul meat. They gulped down each piece with head raised aloft and throat distended. A relatively small lizard swallowed the whole hindquarters of a boar at one gulp, hoofs, hide, hams, backbone and all. After feeding, each lizard licked its chops and rubbed both sides of its head on the ground as if to clean it.

Carrion can scarcely be considered the usual food of the dragon lizard, however. Mr. Burden suspects that it ordinarily preys on the wild hogs and small deer that live on the same islands. The larger

meat-eating mammals are absent from the region, or were until the advent of dogs introduced by man. Free from competition from the higher animals, the giant lizard apparently assumed the role ordinarily filled by the meat-eating mammals. Individuals in zoos have been fed on rats and pigeons, as well as on hens' eggs.

Captive lizards kept in Java often ate their own eggs, which presumably are laid in the ground. A few eggs incubated in Sourabaya produced young with yellowish bands on the tail and similar-colored specks and larger circles on the body. The adults are uniformly brownish gray.

Relatives of the Giant Lizard. The giant lizard is actually one of the monitors. This family is represented by some twenty-five species living in Africa, Asia, and Australia, as well as many of the islands off the coast of Asia. Several other members of the family are large. Except for the crocodile, the Nile Monitor, *Varanus niloticus*, is the largest four-footed reptile in Africa. Individuals five feet long are not rare, and some even attain a length of slightly over six feet.

Nile monitors eat almost anything. They prey on birds, rats, snails, and insects, and also eat carrion. Like some of the monitors in Asia they habitually deposit their eggs in termite nests. The gaping hole left after the female deposits her eggs is quickly repaired by the termites, which do not bother the eggs. These incubate under ideal conditions, for the termites maintain relatively constant conditions of heat and humidity during the long period—nearly ten months—that the embryos are developing.

Interestingly enough the Tegu, *Tupinambis nigropunctatus*, a member of a distantly related New World family known as the Teiidae, has a surface resemblance to the monitors. It too deposits its eggs in termite nests, and in other respects as well appears to fill the same niche in South America that the Nile monitor fills in Africa.

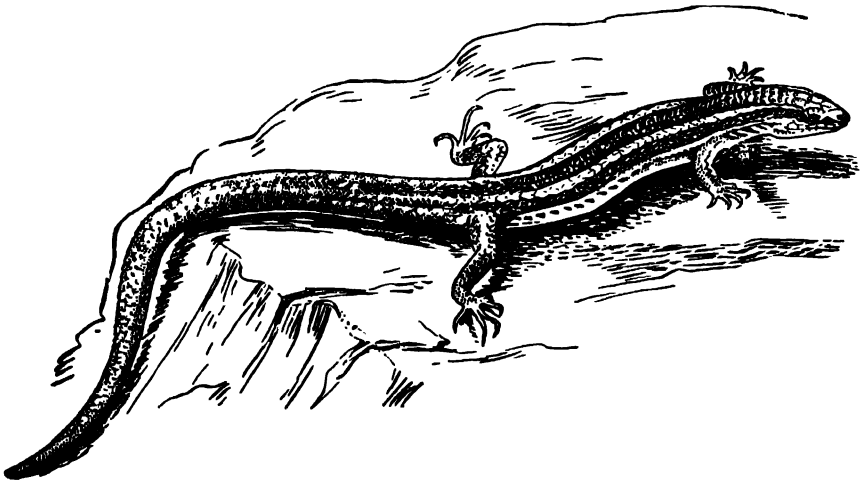
THE SKINKS

The skinks are the most widely encountered of all the saurians. Nearly one-fourth of the existing lizards are skinks—the name is from an ancient Greek word latinized as *Scincus*, meaning lizard. Fewer than two dozen kinds live in the United States, whereas other parts of the world support a much larger proportion of the family (Scincidae). Skinks are abundant in Africa, Asia, and the islands of the Western

Pacific. But they are particularly numerous and attain greater sizes in Australia. Many of the limbless forms assigned to other families probably evolved from the skinks.

In the United States there are only three genera. One includes a single species, the Florida Sand Skink, *Neoseps reynoldsi*. This burrower, with only a single finger on each hand and only two toes on each foot, is confined to the sandy ridge that forms the backbone of the northern half of Florida. Another genus, abundant in Asia, also has only a single species in the United States—the Brown Skink, *Leiolopisma laterale*. The latter, as well as the sand skink, each have a transparent disk or "window" in the lower eyelid.

The Western Skink, *Eumeces skiltonianus*. The skinks of the genus *Eumeces* dwell in North America, Africa, and Eurasia. In the United States the only lizard reaching New England is the Eastern Skink, *Eumeces fasciatus*, which is found as far north as Connecticut. On the Pacific Coast of North America the western skink occupies the entire coastal region from British Columbia to northern Baja California. North of the desert regions, which skinks in the United States generally avoid, the range extends eastward to Utah and Montana.



ONE OF THE MOST COMMON KINDS OF LIZARDS

Skinks make up nearly one-quarter of the different kinds of lizards. The western skink pictured here is typical of the group, with its smooth, shiny skin and darting, forked tongue. This lizard has an unusually sharp sense of smell—useful in finding larvae that are buried underground. Although the animal is abroad by day, we do not glimpse it often.

Like most other members of the skink family, the western skink has flat, round, overlapping scales that are more or less of equal size over much of the body. These give the reptile a glassy-smooth shiny appearance. The upper surface is brown, with a bold light stripe extending on each side of the body from the snout to the base of the tail. Young skinks have a conspicuous cobalt blue tail. The name "blue-tailed skink" is common, although such blue tails are characteristic of the young of many other skinks. Moreover, as the western skink approaches maturity the blue color gradually changes to pinkish brown.

——THE LIFE OF THE SKINK. Skinks are secretive animals. Though they are active during the day, relatively few individuals are seen unless logs or rocks are overturned. They prefer moist places, and are perhaps encountered more often in wooded areas than in the open. Like all members of the family, the western skink has a protrusible forked tongue, indicating that it has an acute sense of smell. Its food consists largely of insects and their larvae. It detects its prey by sight, but it uses its sense of smell to locate insect larvae buried in the earth or hidden under debris.

Many skinks bear fully-formed young, but the western skink lays eggs. Usually these hatch during July and August. The hatchling has a body about an inch long. It doubles its length the first year and attains the adult size of two and three-quarter inches during the third year. The normal life span has been estimated at about five or six years, the oldest individuals being about nine years of age.

THE GECKOS

The geckos are one of the larger families of lizards. Most, but not all, of them are small nocturnal creatures with claws as well as adhesive pads on their feet. Like other reptiles that forage at night, the majority of the geckos have eyes with vertically elliptical pupils. A very few of them, with round pupils, are mostly active in the daytime.

Geckos—they comprise the family Gekkonidae—may live in trees, rodent burrows, rock crevices, on the ground, or even in buildings. Some dig their own holes in the earth, although none is restricted to an underground existence. Geckos are largely insect-eaters; numerous kinds of insects are abroad, like the geckos, during the hours of darkness.

The Tuck-too Gecko, *Gekko gecko.* Nearly all geckos have a voice. It may be only a faint squeak, a chirp, or a clucking sound; or it may be a squawk, a crackle, or a loud cry that can be heard at a distance of a hundred yards. The shrill voices of the African Whistling Geckos, *Ptenopus garrulus,* are said to be well-nigh deafening when a number of them are calling simultaneously.

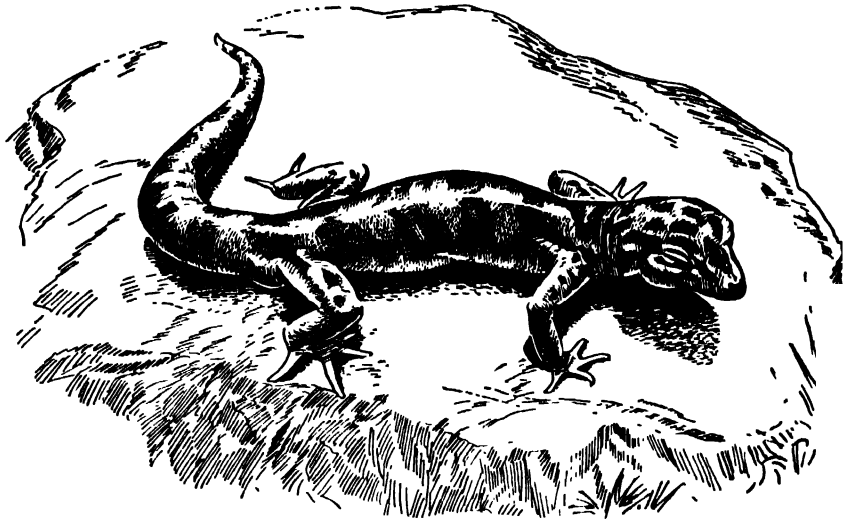
It is appropriate, therefore, that the name "gecko" applied to the members of the far-flung family should be onomatopoeic in origin: "Gecko" reproduces the sound made by the large tuck-too of the Indo-Chinese region. The tuck-too has habits similar to those of other members of the family, but it is one of the larger geckos with a body slightly longer than six inches.

It is one of the "house geckos." Like some of its relatives, it often lives in or around buildings. In southern Indo-China virtually every home or house of any size supports at least one or two of these large geckos. Making good use of the adhesive pads on their broadened toes, they run about on the walls, or even upside down on the ceiling. They accomplish this feat by means of tiny hairlike structures on the pads. These cling to irregularities in surfaces that are not so smooth as they look to the naked eye—suction is not involved.

——THE VOICE OF THE TUCK-TOO. The tuck-too does not call all year around. It begins in the colder part of the year, and continues calling until the onset of hot weather in May. During these spring months some tuck-toos call continuously, one after the other taking up the cry from house to house. Whether or not the call has anything to do with their courtship no one knows for certain. It is noteworthy that reptiles with a voice, the tuatara, crocodilians, and geckos, are all mostly active at night. This does not necessarily imply any connection with breeding activities, although the voice may help a gecko in finding a mate. The tuck-too uses its voice as a frightening device: when cornered it will utter a loud squawk as it lurches forward with its mouth open.

——WHERE GECKOS ARE FOUND. Geckos are particularly abundant in the Orient, as well as in Africa and Australia. There are several in Latin America and less than half a dozen that are native to the United States. This wide distribution points to the antiquity of the stock. Despite their diversification, which is exceeded only by that of the skinks, geckos are further remarkable in having adhered rather strictly to the ancestral habit of depositing no more than two eggs.

They may bury them in the ground, attach them to walls, or lay them in crevices in wood or rock. As long as six months may be required for incubation. Upon leaving the egg, the young gecko immediately casts its skin and eats it. The only geckos known to give birth to fully-formed young are two species that live in New Zealand.



THE BANDED GECKO IS DIFFERENT

Geckos are small, night-prowling, insect-eating lizards that live in all sorts of places, mostly in the tropics. The banded gecko, which dwells in the American Southwest, differs interestingly from the majority of geckos. Lacking the sticky foot pads common to most geckos, this one has claws that it can thrust out and draw in.

Adult geckos commonly devour their skin as soon as it is shed. Most of them are insect-eaters, although the tuck-too preys upon the smaller house geckos as well, and has been known to attack and devour small snakes. The Banded Gecko, *Coleonyx variegatus,* of the American Southwest stalks its prey with all the caution of a cat stalking a mouse, pouncing on it with ludicrous ferocity. The banded gecko is catlike in some other respects, for it lacks the adhesive pads common to most geckos. It is equipped instead with retractile claws which it can thrust out and withdraw.

In the geckos, as in the iguanas, anoles, horned lizards, basilisks, Gila monsters, dragon-lizards, flying lizards, frilled lizards, chameleons, monitors, skinks, and others, we find that same amazing

adaptability that characterizes the lizards as a whole. It is not only the kinds of lizard specializations that fill us with awe—it is also their variety and versatility. But, in all the millions of years of their existence, perhaps the most impressive example of lizard specialization came when these creatures gave rise to a kind of "limbless lizard": the snake.

Snakes—Most Recent of Reptiles

THERE ARE nearly three thousand kinds of snakes. Were there only a few, we would undoubtedly consider them lizards with interesting peculiarities. For that is essentially what they are: lizards with special ways of existence that no longer require limbs as a means of moving about.

However, several kinds of ancient lizards adopted burrowing habits, and in the course of countless generations their limbs became smaller and smaller until they were completely lost. The original lizard that was to become a snake is believed to have gone through these stages approximately a hundred million years ago. Other lizards later went through similar stages. It is not altogether certain that all reptiles now classified as serpents are actually descended from the same four-legged stock.

What usually distinguishes snakes from other reptiles is that the two halves of their lower jaw are connected only by an elastic ligament. Also, the brain case of snakes is enclosed at the front. Their eyelids are not movable, their ears have no outside opening, and they have no breastbone. Hip bones and even traces of limbs may be present in snakes, although the latter are mere spurs noticeable only on careful inspection. Snakes do not use limbs for locomotion. They make up the suborder Serpentes ("crawling animals").

Virtually all structures that are typical of snakes also occur in some lizards. This may be ascribed to the fact that various burrowing lizards have evolved along the same lines as snakes. However, snakes fulfill reasonably well the role for which their form fits them. The limbless lizards of today are probably comparable to the snakes in the early stages of their development. With snakes already on hand and occupying the various niches or modes of existence open to them, the field may have been pre-empted. Even though whole families of lizards are without limbs, members of these groups have achieved neither the habits nor all the structures of true snakes.

WHAT SNAKES FEED ON

It is interesting to note that snakes expanded as a group with the arrival of the rodents. The success of the snakes may well have depended upon the increased abundance of these small gnawing animals. The ancestors of the squirrels, chipmunks, rats and mice were probably the prey of the earlier snakes just as the rodents are today. Many of the snakes, such as the Bull Snakes, *Pituophis*, and the larger Rattlesnakes, *Crotalus*, rely largely upon rodents for their existence.

Nevertheless there are many specialists among snakes, as far as eating habits are concerned. The Hook-nosed Snakes, *Ficimia*, and their relatives, for example, eat almost nothing but spiders, the larger ones preying on tarantulas. The Florida Swamp Snake, *Liodytes alleni*, appears to restrict its diet to crayfish. Snakes in other parts of the world confine their diets to slugs. The Coral Snakes, *Micrurus*, most of them venomous and beautifully marked, definitely prefer other snakes, but they eat lizards on occasion.

One of the more amazing specialists is the Egg-eating Snake of Africa, *Dasypeltis scaber*. The teeth of this serpent are greatly reduced but projections from the spine that actually pierce the throat serve to slit the shell. The snake swallows the contents of the egg and ejects the shell.

A few of the snakes that live in trees, notably some of the boas such as the handsome Dog-toothed Boa, *Corallus canina*, rely largely upon birds for food. Other snakes are not at all particular. King Snakes, *Lampropeltis getulus*, which range from coast to coast in the United States, with many subspecies, eat lizards, rodents, birds, and other snakes as well. Careful studies of a few kinds of snakes

show that preferences may change in the course of a snake's growth. Juvenile rattlesnakes eat lizards, but adults of the larger species more often eat rodents.

In part the food of serpents with catholic tastes, as in many other animals, is dependent upon what is available. When inhabiting someone's garden, the Common Garter Snake, *Thamnophis sirtalis,* in the United States may live on a diet of earthworms. But under exceptional circumstances, when it lives in the vicinity of fish hatcheries for instance, the garter snake may well subsist on a fish diet. When it lives in wooded regions undisturbed by man, it commonly preys on frogs and salamanders.

THE REMARKABLE FEEDING TECHNIQUE OF SNAKES

Both the upper and lower jaws of most snakes, especially the lower jaws, are rather loosely attached. It is this peculiarity that enables snakes to swallow relatively large prey. As mentioned above, the two halves of the lower jaw are attached to each other at the chin by an elastic ligament. Each side of the lower jaw extends beyond the back end of the skull itself, where it forms a joint with another bone that in turn is joined to a small bone firmly attached to the top of the skull.

As the snake starts to swallow a large animal, it ordinarily selects the head as the starting point. The snake opens its mouth and thrusts it over the snout of the prey. The bones in the upper jaw contain teeth that curve backward—recurved teeth—in two rows on each side. The snake thrusts these bones forward, first one, and then the other. The lower jaw, with the right half widely separated from the left, moves in from below, aided by recurved teeth on each side. As the upper jaws pull the prey into the mouth, first one side and then the other is advanced while the teeth in the opposite jaw hold fast. Meanwhile the bone extending from the skull to each side of the lower jaw is swung outward and downward. This broadens the outline of the snake's mouth as it pulls the prey into its throat. Here the skin surrounding the neck is distensible, stretching to permit a large morsel to pass through it as the animal is engulfed.

The snake might have difficulty breathing during the engulfing process, which sometimes requires many minutes, were it not for a special provision. The front end of the stiffened breathing tube, which

ordinarily lies back in the bottom of the mouth, is pushed forward to the edge of the lower lip. Once the prey has been drawn back into the digestive tract, muscles in the body wall tighten in front of it. A constriction or progressive tightening of the muscles carries the prey into the stomach.

HOW SNAKES KILL THEIR PREY

Whipsnakes and racers simply seize small animals, such as lizards, and work their jaws over the head to begin swallowing it. But most snakes kill their prey prior to engulfing it. This they accomplish by means of venom or by constriction. Boas, king snakes, and many others move up stealthily upon a small animal, a mouse for example, which has attracted them. The snake, with its body drawn up in sinuous curves, suddenly straightens out the front part of its body, thrusting the open mouth forward with great rapidity. Its jaws close around the body of the prey, and at the same instant the snake throws several coils of its body around the struggling animal. The coils tighten steadily around the mouse. The hapless rodent seeks to breathe, but its lungs cannot draw in air because its ribs are held in a vise by the coils. Movements of the heart and the blood are brought to a standstill. The mouse suffocates, its life literally squeezed out of it. The snake brings death to its prey quickly and efficiently by means of this constricting method. But there are even more efficient ways of getting food.

Venomous snakes do not constrict. They rely instead upon the injection of a death-dealing substance that comes from glands in the head. The vipers, the cobras, and their relatives are the most advanced in this technique. Their fangs, which lie at each side of the front of the upper jaw, are really tubular teeth, very much like the hypodermic needles that doctors use, but curved instead of straight. The viper's head is launched forward with lightning speed. The instant the fangs are imbedded in the flesh of its prey, muscles surrounding the gland tighten, forcing the venom through a small tube that carries it to the fang, and through it into the victim. In most instances, the prey succumbs in a matter of minutes, or even seconds.

It should be emphasized that venomous snakes use their fangs primarily for getting food. The fangs serve only incidentally as a means of protection, although the fangs of spitting cobras are specially modi-

fied for defense. Poisonous snakes are discussed in greater detail in the next chapter.

WHERE SNAKES LIVE

As you can see from this summary of their feeding habits, snakes are remarkably adaptable animals. They live in a great variety of places in nearly all parts of the world. The Common European Viper, *Vipera berus*, has even penetrated to land north of the Arctic Circle, in the Scandinavian Peninsula. Here it survives only because the region is near warm ocean currents. Snakes avoid cold regions, or those with short summer seasons. There are no snakes in Alaska and the more northerly parts of Asia and Europe, where the ground below the surface is permanently frozen.

Snakes are abundant in Australia, the only continent where venomous snakes outnumber the harmless kinds. Nevertheless no snake ever succeeded in reaching, or at least in establishing itself, in New Zealand. Some of the oceanic islands—those that never had any past connection with a mainland or continent—are commonly free of snakes. Nevertheless a few snakes have succeeded in reaching some small isolated land masses.

The Hawaiian Islands had no snakes until relatively recently, when the Indian Blind Snake, *Typhlops braminus*, appeared. Apparently it was accidentally brought to the island in some sort of produce. This snake is exceptional in its ability to survive and to perpetuate itself in some parts of the world where it has been introduced. It has now appeared in Africa, Cuba, and Mexico, usually near the coast. This suggests its accidental introduction through commerce.

WHY THERE ARE NO SNAKES IN IRELAND

There are no snakes in Ireland—but not because Saint Patrick drove them out! During the glacial epochs, over ten thousand years ago, the polar icecap pushed southward. It covered much if not all of Ireland and the larger part of England. It is doubtful whether any amphibians or reptiles survived in the British Isles.

When the icecap withdrew to the north, so much water is believed to have been frozen on land that the level of the oceans was lowered. England and Ireland were connected with the mainland. The English

Channel was a river valley. Only a dozen of the reptiles and amphibians in continental Europe managed to reach England before it was again cut off by the rising seas as the icecap began to melt. Ireland, being farther from the mainland, was cut off first. Two amphibians and one lizard succeeded in reaching Ireland, but the sea had already separated it from England before a single snake could cross. Only three of the thirty-two kinds of snakes in Europe managed to reach England.

Snakes Without Poison Fangs

THE GIGANTIC CONSTRICTORS

ALL THE truly large snakes are either boas or pythons—and this holds for the past as well. But this does not mean that *all* boas and pythons are large snakes.

The boas, or members of the subfamily Boinae, are primarily inhabitants of the New World. Nevertheless there are boas in Madagascar; the Sand Boas, *Eryx,* live in some parts of Europe, Asia, and Africa; there are boas in the Malay region. The Rubber Boa, *Charina bottae,* adults of which rarely reach two feet in length, ranges farther north than other species. It is confined to the cooler forested regions of western North America, from British Columbia to southern California, and eastward to Montana. A second species native to the United States is the Rosy Boa, *Lichanura roseofusca,* which lives in the arid and semiarid regions of the American Southwest. All told, the constrictors make up the family Boidae.

Pythons, representatives of the subfamily Pythoninae, are found only in Asia, Africa, and Australia, with the single exception of the

small Mexican Python, *Loxocemus bicolor.* Actually the differences between pythons and boas are rather minor. Both have telltale indications including vestiges of hind limbs, that mark them as primitive. They are closely related members of a stock that must be at least sixty million years old. There appears to have been a general decline in size. Scanty as the fossil record is, it points to the existence of boas of greater dimensions in bygone eras.

GOLIATHS OF PAST AND PRESENT

The fossilized remains of a snake found in the Eocene deposits of Egypt, which consist of rocks laid down between forty and sixty million years ago, belong to a boa estimated to have reached a length of fifty feet! In rocks of similar age in central Patagonia Dr. George Gaylord Simpson discovered part of the skeleton of a large constrictor that he named *Madtsoia bai.* He believes that the creature represented must have been about thirty-five feet long and possibly more. Consequently it is reasonable to assume that still larger snakes of the same species once existed; for there is little likelihood that the single specimen uncovered would be the largest.

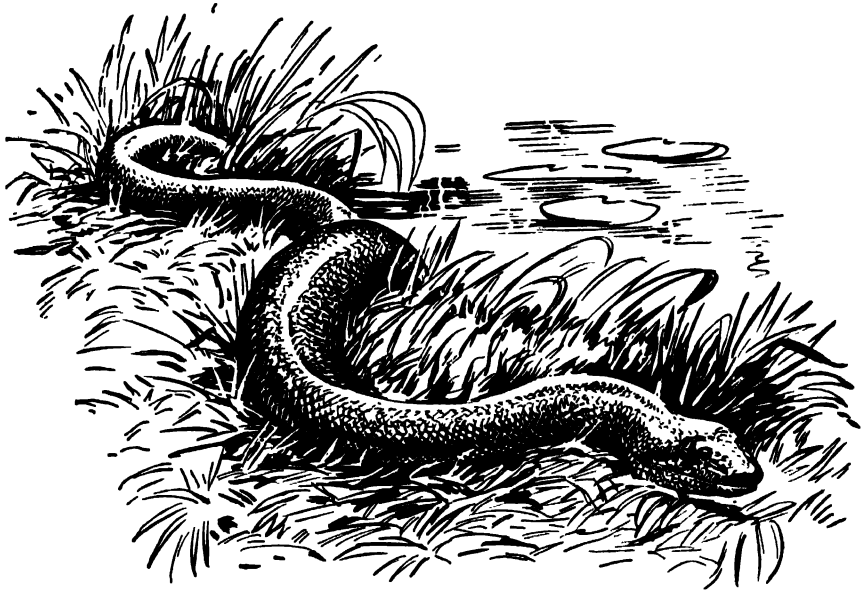
Few other snakes of great dimensions are known in the fossil state. However, in 1926 Professor J. Graham Kerr of the University of Glasgow in Scotland described what he believed to be the venom-conducting tooth of a huge serpent. The supposed fang, which measures nearly two and one-half inches along the outer curve, turned up in relatively recent deposits in the Gran Chaco of South America. No other parts of the animal were found. Assuming that the tooth belonged to a rear-fanged snake similar in proportions to the African Boomslang, *Dispholidus typus,* it has been speculated that the tooth indicated a serpent approximately sixty feet long. Such outlandish proportions can scarcely be attributed to a rear-fanged snake. The fossilized fang, if such it be, bears little resemblance to those of any snake now living. It may very well be a fragment of some totally unrelated animal.

Among present-day snakes the Reticulated or Regal Python, *Python reticulatus,* probably holds the record for length. Specimens twenty-eight feet long that weighed two hundred pounds have been well authenticated, and thirty-three feet has been suggested as the possible maximum. This snake lives in southeastern Asia, the Malay Penin-

sula, and the adjacent islands, including the Philippines. The Indian Python, *Python molurus,* which ranges from Ceylon and peninsular India to southern China, is a smaller species with a maximum size of about twenty feet. A very close relative of the latter is the Rock Python, *Python sebae,* of Africa, with a verified maximum that does not exceed eighteen feet. The largest snake in Australia is the Queensland Python, *Python amethystinus,* reputed to attain a length of twenty-one feet.

TALL TALES ABOUT NEW WORLD SNAKES

There is little doubt that in the Western Hemisphere the largest snake is the Anaconda, *Eunectes murina,* of South America. Snakes of incredible size have been reported from Brazil since the earliest days of exploration. Lieutenant William Lewis Herndon, who traversed the country in the middle of the nineteenth century, heard stories of large serpents, and comments that it is "almost impossible to doubt"



THE ANACONDA—FAVORITE OF TALL TALES

Twenty feet long or thereabouts, the anaconda is the largest snake of the Western Hemisphere. Though this monstrous reptile is the subject of many a tall tale, there is no first-hand report of an anaconda's doing away with a human being.

the account of Father Manuel Castrucci de Vernazza. Writing in 1845, this gentleman says that the snake called the Yacu Mamma or "mother of the waters . . . which I killed from my canoe upon the Pastaza (with five shots of a fowling piece) had two yards of thickness, and fifteen yards of length; but the Indians of this region have assured me that there are animals of this kind here of three or four yards in diameter, and thirty to forty long."

This should have been the story to end all snake yarns! Instead the story has been passed on and further embellished in recent years. An enterprising photographer in Brazil has distributed pictures of a large, evidently bloated anaconda that reputedly weighed five tons. The card depicting it states that it is eighty cm. (thirty-two inches) in diameter, and forty meters (131 feet) long. This misinformation has been widely accepted as fact. The identical photograph has reappeared at intervals over a period of a dozen years, each time accompanied by a totally different story. A newspaper account that appeared in 1948 describes a snake 156 feet long that was killed by a detachment of the Brazilian army. After a battle, during which the serpent "knocked down buildings—and upset autos with its mighty bulk," according to the ridiculous story, the serpent was finally killed.

Although they have not been taken in by such weird myths, reputable scientists have been led to believe that anacondas forty feet long do exist. The truth of the matter is that even a length of twenty-eight feet cannot be fully substantiated. Too many measurements have been based on skins, which provide exaggerated notions of the size of the living animal. The skin of a twenty-foot anaconda might easily be stretched to twenty-eight feet. Interestingly enough, the length of the average large adult is approximately nineteen to twenty-two feet.

The Boa Constrictor, *Boa constrictor,* is so widely known that even its technical name has become a household word. It is commonly thought of as being the "largest snake." Actually it is exceeded in size by the pythons mentioned above, and it is only the runner-up in the New World. It is found in the lowlands of both North and South America, from northern Mexico to Argentina. Specimens exceeding twelve feet in length are uncommon, although larger examples are often reported. Dr. Colin F. Pittendrigh of Princeton has informed me that he measured one found in Trinidad that was eighteen and a half feet long. This appears to be the largest one actually measured.

THE PREY OF PYTHONS AND BOAS

The available records indicate that the reticulated python preys upon comparatively small mammals—small, that is, in proportion to the size of the snake. Animals weighing more than one hundred pounds are seldom eaten by even the largest individuals. Major Stanley Flower, who lived in Bangkok where the reticulated python was abundant, even inside the city, states that such snakes make an easy living devouring fowls, ducks, cats and dogs. In Borneo they commonly eat young wild hogs.

The Indian python has a much more varied diet, being known to prey upon toads, reptiles, fowls, water rats, barking deer, and hog deer. One is known to have overcome a leopard having a body four feet two inches long, which it devoured afterward. Colonel Frank Wall tells of a Chinese baby being eaten by a python on an island near Hong Kong.

The African rock python is readily maintained in captivity on a diet of guinea pigs or fowls, but we know little of its food habits under natural conditions. Mr. Arthur Loveridge reports the killing and subsequent examination of several rock pythons that had swallowed Thompson's Gazelles. He also gives one of the better authenticated accounts of a rock python's attack on a human being. A native woman living on an island in the southwest corner of Lake Victoria Nyanza was seized while she was washing clothes beside a stream. She was discovered dead in the coils of the python by a native who summoned men from the nearby village. They killed the snake, which was found to measure somewhat less than fifteen feet.

The reticulated python has also been known to attack and devour humans upon occasion. One that devoured a fourteen-year-old boy in the Dutch East Indies was captured and killed two days later, when the body of the unfortunate lad was recovered. Other cases have been reported, although relatively few have been fully substantiated. On the whole it is most exceptional for human beings to fall victim to pythons.

There are no eyewitness reports of anacondas devouring humans, although it is obvious that a large one could easily overpower an unarmed man. Anacondas are largely but not strictly water-dwelling in their habits and it is likely that many of the larger South American

rodents provide most of their prey. Captive anacondas have been fed birds as well as mammals, and young anacondas are said to prefer fish. Franz Werner reports that one attacked a small crocodile temporarily placed in the cage with it. Perhaps caimans or crocodiles, which often share the anaconda's habitat, are eaten from time to time.

Boa constrictors occasionally devour rabbits in Sonora, Mexico, where they also make nuisances of themselves by eating young pigs and chickens. In Trinidad Mr. R. R. Mole found young deer as well as agoutí and ocelots in the stomachs of freshly captured specimens. In Paraguay, boas are reported to feed on rodents, and a "mountain cat" is known to have been devoured by one. Thus we see that most of the larger snakes have catholic tastes, with the smaller mammals comprising the bulk of their diet.

HOW SNAKES DETECT THEIR PREY

Many pythons and some boas have depressions known as labial pits in the scales bordering the mouth. These are readily apparent in the smaller kinds and quite conspicuous in some of the larger species. These pits, which are lined with nerve endings, serve as heat detectors, or special organs that enable the snakes that possess them to detect the presence of warm-blooded prey. Moreover, the paired arrangement of the pits provides depth perception. Snakes are able to judge their distance from mammals or birds, and to launch their biting apparatus with considerable precision.

Boas and pythons have eyes with vertically elliptical, catlike pupils, presumably adapted for seeing in dim light. The sense of smell, as well as sight, is used in locating food, but the heat detectors in the lips probably play an important part in the actual seizure of the prey.

WHERE BOAS AND PYTHONS LIVE

Boas and pythons are largely nighttime creatures. Most of them dwell in moist, forested areas. Those in dry regions are more likely to be encountered during periods of wet weather. I have found the rosy boa abroad and active on foggy days in San Diego County, California, when no other reptiles were on the surface. The only boa constrictors I have seen in their native haunts in Mexico, appeared during or

immediately following rains. The Desert Boa, *Lichanura roseofusca gracia,* is largely nocturnal, although it is active at times during the early morning or at twilight. The Rubber Boa in California is evidently able to tolerate the low temperatures of its mountain home, where it is largely confined to moist forests.



THE BOA CONSTRICTOR SEEKS THE SCENT OF ITS PREY

The boa constrictor, pictured above, relies largely on its sense of smell to find its prey. Less familiar is the method employed by some of its relatives in detecting the presence of warm-blooded prey. Pits along the lips of some boas and pythons are so sensitive to temperature changes that the reptiles become aware of the presence of warm-blooded creatures at a distance of a yard or more.

HOW BOAS AND PYTHONS BREED

Boas, without any known exception, give birth to fully-formed young. Pythons, on the other hand, lay eggs. The mother coils about the eggs and remains with them until they hatch. The number of eggs laid depends upon the size of the parent, but as many as 106 have been reported for the reticulated python. Incubation takes from sixty to eighty days, during which time the "brooding" parent may have a body temperature as much as 6° Fahrenheit above that of the ground on which she is resting. Air temperatures may be considerably lower —a fact that has given rise to the misguided notion that the brooding python produces more body heat than it actually does.

LONG-LIVED SNAKES

The larger snakes hold most of the longevity records for snakes. This may be ascribed to the fact that they are more commonly exhibited in zoological gardens, the source of the few available records. An anaconda lived for nearly twenty-nine years in the National Zoological Park in Washington. Large snakes survive for long periods without eating—commonly for a year or two, as long as water is provided. According to Sir Charles Martin, one fasted for well over three years.

With proper care many snakes survive for long periods. Mr. C. B. Perkins, who is in charge of snakes in Balboa Park in San Diego, California, has been successful in keeping many kinds of snakes for a decade. Suitable quarters have been available only during this period, and most of these snakes are still living. The chances are, therefore, that Mr. Perkins will establish much greater ages for many species. It is probable that under natural conditions large snakes live for twenty or thirty years, or even longer. Mortality among juveniles is probably high, but a full-grown reticulated python or an anaconda has few known enemies except man.

OTHER NONVENOMOUS SNAKES

In addition to the boas and pythons, there are several other families of nonvenomous snakes. In fact, nearly four-fifths of the living species are essentially harmless as far as man is concerned. The vast majority of snakes do not possess fangs and are too small to attack a human being. Several families are made up solely of snakes without fangs.

THE BLIND SNAKES

Most members of this family are secretive burrowers, living underground or in decaying wood or vegetation, where they prey upon insects and their larvae. Some live in the nests of termites, the so-called "white ants," which are abundant in the tropics.

The blind snakes live in the extreme South of Europe, southern Asia, Africa, Australia and tropical America, including the West Indies. The smaller species have a wormlike appearance—though some of the large blind snakes of Africa are more than an inch in diameter and as much as two feet long. The blind snakes make up the family Typhlopidae.

As the name "blind snakes" implies, the eyes, which are scarcely discernible black dots beneath the polished scales on the head, probably do not function at all. Some of these snakes have traces of hip bones, others lack them completely. Except for a few representatives in tropical America that have a single tooth inside the lower jaw, their teeth are curved back and confined to the upper jaws. Some blind snakes lay their eggs, others keep them in the body until ready to hatch.

THE WORM SNAKES

The worm snakes are all slender burrowers, with mere vestiges of eyes. They resemble the blind snakes to some extent, but differ from them in having teeth only in the lower jaws. The worm snakes have traces of hip bones and hind limbs. We know relatively little about their habits, aside from the fact that they are insect-eaters. They comprise the family Leptotyphlopidae and are found in the American Southwest as well as in the American tropics, Africa, and southwestern Asia. In the American Southwest they are usually found under rocks or, less commonly, crawling on the surface at night.

THE SHIELD-TAILED SNAKES

The shield-tailed snakes use the snout for burrowing through the soft earth where they usually live—in mountainous or forested districts in peninsular India and Ceylon. These snakes are apparently aided in their burrowing activities by the fact that their jaws are joined to the

bone supporting the snout; the bones of the skull are solidly united so that, unlike most snakes, the shield-tailed snakes cannot move their upper jaws independently. These snakes—they are all grouped in the family Uropeltidae—are small, seldom growing more than a foot long.

The tail ends in a peculiar fashion. In some species the tip is covered by a single large shield with ridges. On others the tail looks as though it had been sliced off at an angle, the resulting surface being covered with large, strongly keeled (ridged) scales—or by a single scale. Some scientists have suggested, without much evidence to support their view, that this "shield" serves as a sort of "burrow stopper," protecting the snake from attacks at the rear.

As far as we know, all shield-tails give birth to from three to eight fully-formed young. Captives have been fed worms and the soft-bodied larvae of insects.

THE PIPE SNAKES

These are all secretive, burrowing snakes, with relatively small heads and short tails. Though they have characteristics of both the shield-tails and the boas, the pipe snakes also have structural peculiarities that set them off from these and other families. As in the shield-tailed snakes, the upper jaws of the pipe snakes are solidly united to the skull. These snakes also have traces of hip bones, and of hind limbs that end in a clawlike spur on either side of the vent—like the boas.

Relatively few species of pipe snakes are known. Most of them live in the Indo-Chinese region and in the East Indies, although a single species is found in tropical South America. The pipe snakes—they compose the family Anilidae—usually have reddish markings, and the South American Pipe Snake, *Anilius scytale,* is sometimes mistaken for a coral snake for this reason.

THE SUNBEAM SNAKE

The sunbeam snake—there is only one species, *Xenopeltis unicolor,* in this family—gets its name from its highly polished iridescent scales. It is a common snake in Burma, Siam, and southern French Indo-China, where it occasionally exceeds six feet in length. Living in the earth, or beneath logs or stones, it comes to the surface at night to

feed. It preys upon other snakes, frogs, and small rodents. In some ways the sunbeam snake combines the peculiarities of other families. But this single species—it makes up the family Xenopeltidae—is unique in having three scales at the back of the head where most snakes of the closely related families have only one pair.

THE COMMON HARMLESS SNAKES

Some of the best-known snakes in the United States—such as the racers, whip snakes, king snakes, hog-nosed snakes, bull snakes, water snakes, and garter snakes—are colubrids. In fact, throughout much of the world the snakes one ordinarily sees are members of the family Colubridae; the subfamilies make up two-thirds of all the snake species now living.

Several colubrids have grooved, but not tubular, fangs at the rear of the upper jaw. Although a few of them are capable of inflicting a somewhat painful bite, only one of the rear-fanged snakes is dangerously venomous. The family includes snakes that live on the surface, and some that burrow beneath it. Others frequent trees, while there are some that are partly water dwellers, doing much of their feeding in streams, ponds, or marshes.

The Grass Snake, *Natrix natrix,* the most abundant snake in Britain, is also common throughout much of Europe, with the exception of the far North. On its home grounds this snake is retiring and unobtrusive. If it is molested, it usually glides swiftly away. But if it is seized, two glands at the base of the tail give off a substance with a powerful and offensive smell. Many other snakes are equipped with similar glands, but few have quite so evil a stench as the water snakes.

Several races of grass snakes are now recognized, each differing in minor respects from the others. They all have keeled scales and blackish or greenish bodies. The most conspicuous feature of the variable pattern is a brilliant yellow or orange collar which accounts for the alternative name of Ring Snake—*Ringelnatter* in Germany and Austria.

——WHERE THE GRASS SNAKE LIVES. A relative of the American water snakes, the grass snake is usually encountered in damp, marshy districts. It may be seen on grassy banks or undulating fields—'though its favorite haunts are old quarries in the neighborhood of ponds and

streams. The grass snake is an excellent swimmer, and we have many reports of its being seen at sea, often several miles from the shore.

In keeping with its water-dwelling habits this snake lives mostly on frogs, toads, salamanders, and fish. It evidently prefers amphibians, seeking fish only when other food is not easily available. It seizes and swallows its prey without first killing it.

——THE BREEDING HABITS OF THE GRASS SNAKE. Despite its close relationship with American water snakes, all of which give birth to fully-formed young, the European grass snake lays eggs. These it deposits in the late spring, in manure piles or any convenient collection of rubbish. Its eggs, anywhere from fifteen to forty, have been found in all sorts of places, however—in rotting logs, old walls, or any warm, moist vegetable material. Each individual egg is about the size of a pigeon's. The flexible whitish shells of the eggs often stick to the young even after they have slit the shell and departed.

Ordinarily the young hatch during the autumn. During incubation the eggs absorb moisture from their surroundings, becoming larger as the embryo develops. As with all oviparous (egg-laying) snakes, the hatchling is provided with a temporary, razor-sharp structure: the "egg tooth" at the end of its snout. This is used to cut the leathery membranes that enclose the embryo during its long period of development.

Grass snakes are hardy in captivity, and relatively easy to feed. The average size of an adult is about three feet. Exceptional individuals exceed five feet in length, rarely approach six.

——OTHER WATER SNAKES. Water snakes are plentiful in eastern North America, all the way from southern Canada to Vera Cruz in Mexico. Like the European grass snake, most of these snakes have a marked liking for water life; the eating habits of the two groups are very similar. However, some water snakes have a more specialized diet, limiting themselves more or less to crayfish. Other water snakes eat earthworms and slugs. In the neighborhood of fish hatcheries the Common Water Snake, *Natrix sipedon,* becomes a pest, feeding as it does on the smaller fish. Under natural conditions it captures few game fish.

Throughout the eastern portion of the United States, water snakes are commonly mistaken for the venomous water moccasin. From a distance it is difficult to distinguish between the two, although along the Atlantic coast the true water moccasin is not found north of south-

ern Virginia. Water snakes differ from the moccasins in having a round rather than an elliptical pupil, and in having a double row of plates under the tail. (The moccasin has a single row except at the tip.) Moreover, the moccasin has a pit between the eye and nostril—a structure never found in the water snake.

Needless to say, only the moccasin has fangs, but these may be folded back under a protective sheath of gum tissue, and in a dead snake must be pried forward for examination. Some of the common water snakes have rather large heads, sharply set off from the neck. Thus the shape of the head does not provide a reliable means of distinguishing harmless snakes from the venomous ones.

Water snakes—all members of the genus *Natrix*—are abundant in other parts of the world. Of more than fourscore species, somewhat more than half of them live in Asia and the adjacent regions, including the north coast of Australia. A few are found in Africa. There is a single species on the west coast of Mexico, and one that inhabits the brackish coastal waters of Florida has reached Cuba—probably in relatively recent times. Strangely enough, no water snakes are found in the United States west of the Rocky Mountains.

The Common Garter Snake, *Thamnophis sirtalis*, is one of the most widely distributed and most frequently encountered snakes in the United States. The garter snakes illustrate an interesting principle in nature: When two or more species live in the same area, their habits are never identical. One may be less restricted to water than another, or they may differ in adult size or in food preferences—commonly in both. Usually they breed at different seasons. Careful studies have shown that closely related species in the same region are hardly ever in direct competition with one another. The same rule applies to virtually all other animals.

——WHERE GARTER SNAKES ARE FOUND. Though the common garter snake and its close relatives are limited to North America, they are quite numerous there. Every state of the United States, as well as each of the southern Canadian provinces, is inhabited by the common garter snake or one or more related species. Like the water snakes, the garter snakes have keeled scales and a disagreeable smell; but the garter snakes differ in having a single plate rather than a divided one at the vent.

Despite the close relationship between the two groups, the garter

snakes are less likely to be limited to the vicinity of water. The common garter snake, with several subspecies, is found from the Atlantic to the Pacific. In the East it is the snake most likely to turn up in gardens, where it preys on earthworms, salamanders, frogs, and toads. In the West it is more often encountered in fields, or in bogs, marshes, and the edges of creeks. It shuns the deserts, while the borders of such streams as the Colorado River are the haunts of other kinds of garter snakes.

——THE PROLIFIC GARTER SNAKE. All the garter snakes give birth to fully-formed young. There are often more than twenty in a litter, and large individuals may give birth to three times this number. Seventy-eight is about the maximum. Garter snakes are among the first snakes to emerge in the spring, and usually the last to retire for the winter months.

By and large the common garter snake is not a very handsome creature, most individuals being gray, with ill-defined stripes. A few, particularly in the West, are patterned with olive green on the sides, with a yellow stripe down the center of the back flanked by red blotches. Patterns vary quite a bit, however, not only from district to district, but even within the same area.

The Eastern Hog-nosed Snake, *Heterodon platyrhinos,* is famous for its bag of tricks: It makes a vivid pretense of ferocity, and it is equally adept at playing dead. The hog-nosed snake is a stout-bodied, slow-moving serpent, superficially viper-like in appearance. It may have a pattern of squarish blotches, or a row of whitish circular markings down either side of its back. Melanistic (uniformly black) individuals are quite common in most parts of its range, and appear to be even more abundant in the southern part of the United States. The average length is about two feet; a length of more than three feet is rare.

——MOCK FEROCITY. When encountered in the field the hog-nosed snake is quite unlikely to glide away silently as ordinary snakes do. It holds its ground, coiling its body as it inflates its lungs to capacity. Approach it closely and it may hiss loudly as it strikes out boldly toward the intruder. And if it is molested further, it may change its tactics and flatten the entire front end of its body to form a sort of "hood" not much like the cobra's, which is restricted to the region behind the head. The hog-nosed snake continues to hiss throughout

these contortions. In the South it will often open its mouth, spreading its jaws wide as though imitating the water moccasin—also known as the "Cottonmouth" because of a similar display of the whitish lining of the mouth.

——PLAYING DEAD. If these antics fail to alarm the enemy, the creature still has one trick left. It contorts its body, writhing as though in agony. Then the snake rolls over on its back and lies perfectly still, the mouth agape and the tongue hanging out with dirt and debris adhering to it. The snake looks as though it had died a horrible death. Pick it up and it remains limp and seemingly lifeless, even if carried about. But place it on the ground right side up and it promptly rolls onto its back, thereby exposing its sham!

It is difficult to appraise the survival value of such behavior, as we know little about its effect on enemies other than man. The ferocious gyrations are all humbug: The hog-nosed snake will not bite, no matter what the provocation! Even when it strikes, its mouth is closed. Nevertheless, it is widely feared, especially in the South. Its behavior has gained it a fearful reputation perpetuated in such names as checkered adder, sand viper, puff adder, and spread-head.

The hog-nosed snake's upturned snout appears to be associated with digging tendencies, although this snake is not a true burrower. It preys almost entirely on toads, but it also devours other amphibians and an occasional bird.

There are two additional species; one, the Western Hog-nose, *Heterodon nasicus,* lives on the western plains, ranging from Montana southward to central Mexico. The other occupies a restricted range in the Carolinas, southward to Florida, with an extension of the range northwestward to Indiana. The western hog-nosed snake has a more pronounced snout than the others, and preys on lizards as well as toads and small mammals.

Like the majority of snakes in the United States, the eastern hog-nosed snake mates in early spring. In June or July it lays anywhere from eight to forty eggs that hatch in the fall. The young vary in length from six to eight inches.

The Western Bull Snake, *Pituophis catenifer,* is of great value to man because of the part it plays in the destruction of rodent pests. The bull snakes and their eastern relatives—the Pine Snakes of the Atlantic coastal plain—are among the larger snakes ordinarily encountered

in the United States. It is not uncommon to find individuals six feet long in the Middle West and in Arizona; a specimen seven feet, eight inches long has been reported. Bull snakes are unbelievably abundant in farming areas. While crossing Iowa and Nebraska in the spring, probably during the bull snakes' mating season, I have come across more than one per mile dead on the road.

——THE BULL SNAKE AS A PEST EXTERMINATOR. Few other snakes, aside from the rattlers, are quite so important as killers of rodents. It is therefore unfortunate that bull snakes are fond of basking in such open areas as roads, where cars are likely to run over them. Nowadays some of the more enlightened farmers try to protect such snakes. The farmers realize that ground squirrels, pocket gophers, mice, rats, and other obnoxious rodents can be held in check more safely and easily with the aid of the bull snake than by trapping or poisoning campaigns.

On the other side of the ledger, bull snakes do some damage in game refuges, where they devour the eggs of ducks, quail, and other ground-nesting birds. On balance their destruction of rodents probably outweighs such damage. It may well be that the birds would fare even worse if rodents were allowed to multiply and compete for the seeds or plants consumed by the birds.

——HOW THE BULL SNAKE PREYS ON RODENTS. In the Southwest the bull snake appears to be one of the few important enemies of the pocket gopher. These rodents commonly damage lawns and may even kill young trees. While I was living in Los Angeles a pocket gopher invaded my yard. Working underground, it ate all the roots from a small fig tree. Traps failed to catch it—but a bull snake evidently succeeded.

I freed the snake in the vicinity of the gopher as it worked on its burrow, carrying earth to the surface. The snake slowly approached the rodent, which seemed oblivious of its danger. When close enough, the snake suddenly struck. But the gopher ducked into its hole, pursued by the snake. I waited for a hour but neither reappeared. The damage to the garden ceased, and three months later I found the snake, sleek and fat, living in a nearby vacant lot where gophers abounded.

No doubt the rodent was killed underground. The bull snake in the Middle West is known to be capable of killing rats in their narrow tunnels by compressing them against the wall. Above ground,

these large snakes are powerful constrictors, usually dispatching their prey in a matter of a few minutes before swallowing them.

Dr. A. F. Carr witnessed a fight between two raccoons and a Florida Pine Snake, *Pituophis melanoleucus*. The fight lasted more than an hour and wound up with the raccoons having much of the skin ripped from their noses, while the snake crawled away unharmed. In California I have seen a red-tailed hawk carrying away a large serpent that was probably a bull snake.

——How the Bull Snake Hisses and "Rattles." Bull snakes are equipped with a thin flexible membrane on the epiglottis (the thin plate of cartilage that protects the end of the breathing tube). Air forcibly expelled from the lungs causes this membrane to vibrate, producing a whirring noise along with the hiss. At the same time the snake's tail vibrates and its jaws spread while its head is flattened. It gains some resemblance to a rattlesnake thereby and doubtless frightens its enemies, regardless of whether or not they mistake the harmless bull snake for a venomous rattler. The loud noise has earned it the name "blow snake" in Utah. In California the same species is commonly called "gopher snake" for obvious reasons.

——How Bull Snakes and Pine Snakes Breed. The habits of the bull snakes and pine snakes are very similar. Both mate during the spring, and deposit their eggs in July. The young come out in the fall, when they often appear in considerable numbers. The eggs, a little over two inches long, are usually buried in the ground. The snake uses its well-developed snout to dig or to push its way into the soil. The pocket gopher fails to keep such snakes from its burrow by filling the entrance with earth.

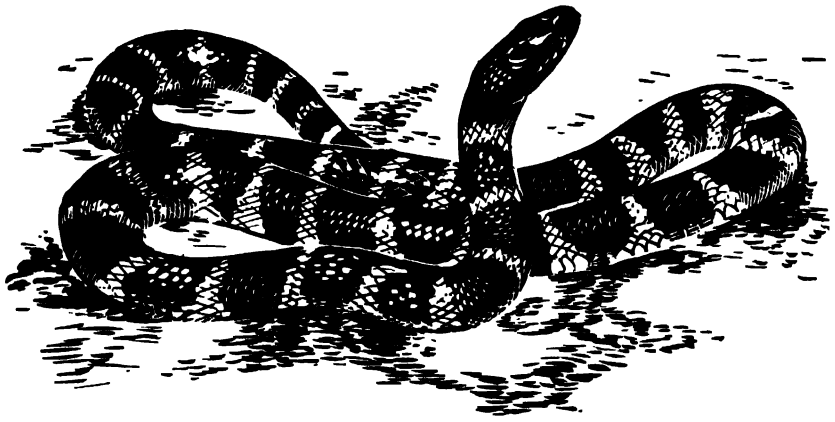
The Racers, *Coluber constrictor,* and **Whip Snakes,** *Masticophis flagellum,* are long, slender-bodied, fast-moving serpents. With their various subspecies, they range from the Atlantic to the Pacific. Despite their specific name, the racers are not constrictors at all. The racer seizes smaller animals—usually by the head or neck; then, sometimes pressing the prey against a fold of its body, the snake "walks" its jaws around to the snout to begin swallowing. Racers eat almost anything, devouring insects, rodents, frogs, toads, lizards, and snakes. The whip snakes are partial to lizards, but they also eat small mammals and birds.

The racers in the East generally take to the trees to avoid capture.

Whip snakes do this less frequently; they rely upon their speed on the ground. They are exceedingly swift, but their speed is somewhat illusory. Such obstacles as shrubs, rocks, or debris are no deterrent to these slender animals; in fact, a human being cannot outdistance a frightened whip snake on this kind of terrain. But if the snake is placed in the open, a fast walk is enough to keep abreast of it. The snake's maximum speed is probably no more than eight miles an hour—even when it is badly frightened.

Owing to the arrangement of the scales on the long slender body, the appearance of the whip snakes suggests the old-fashioned braided rawhide whip. They are sometimes called "coach whip snakes" for this reason. The maximum known length is eight feet, two inches—recorded for the eastern whip snake. Racers are somewhat smaller, usually a yard or so long, rarely if ever exceeding five feet. The upper parts of adults are almost solid in color: blackish, bluish, or greenish, depending on the region where they live. The juveniles are blotched, but this pattern changes to the solid color during the first two years of life.

The King Snakes, *Lampropeltis getulus,* and the **Milk Snakes,** *Lampropeltis doliata,* and their relatives, are among the most successful American snakes. They are all constrictors, inclined to be secretive, and active at night as well as by day. Despite the fact that they eat a



THE KING SNAKE—A CANNIBAL

Constrictors that feed on other snakes, king snakes are famous for their ability to overpower rattlesnakes. However, they do not tackle the larger rattlers. Remarkably enough, king snakes are virtually immune to the venom of pit vipers.

wide variety of small animals, the king snakes are better known as enemies of rattlesnakes. They do, indeed, overpower small rattlesnakes, but rarely tackle rattlers that are not considerably smaller than themselves. Like other harmless North American snakes—but unlike lizards—they are immune to the venom of pit vipers. No one can say why the venom of rattlesnakes has no effect on king snakes.

It is doubtful whether any snakes are immune to the bite of true Coral Snakes, *Micrurus*. For these venomous relatives of the cobras subsist largely upon other snakes, and use their fangs to kill them. Where there are coral snakes, the milk snakes often resemble them in color. For this reason the bright-colored milk snakes are known as false coral snakes. The true coral snakes, confined to the South in the United States, ordinarily have red bands with yellow borders. By way of contrast, the false coral snakes have red bands with black borders. In New England, as well as in the mountains at least as far south as Virginia, adult milk snakes are usually blotched with brown and black and the belly is checkered with white.

THE MILK SNAKE MYTH

Owing to the fact that milk snakes frequent barns and stables, they have become victims of the myth that snakes suck milk from cows. Actually the snakes are probably attracted by the small rodents that abound in such places. In any event, snakes are incapable of extracting milk, and the amount that a milk snake could hold would never be missed by the most conscientious dairyman. Myths like this one go back to ancient times. In virtually every continent some unfortunate serpent that may actually be beneficial to man is designated as the "culprit."

——Other Myths About Snakes. Another fabulous creature is the "hoop snake." There is a myth that this serpent can put its tail in its mouth and roll. In its most amusing form the myth states that the serpent's body can be launched tail foremost—like a javelin. Trees pierced by it are reputed to wither and die. It seems incredible that such nonsense should be taken seriously; yet the yarn is widely accepted. The Mud Snake, *Farancia abacura,* a handsome creature found in the swampy lowlands of the South in the United States, is sometimes cited as evidence. This snake has a stout, rather unusual spine on the tip of its tail. If the serpent is handled, it may press its

spine on the skin of one's arm or hand. Although this action is quite harmless, the reptile is sometimes dubbed a "stinging snake."

Whip snakes, according to legend in some regions, can "whip a person to death." This fanciful notion arises from the snake's superficial resemblance to the braided whip, noted earlier in this chapter.

Even more persistent and widespread is the notion that snakes swallow their young to protect them The young of some fishes do indeed retreat in time of danger into the parent's mouth. But the young of live-bearing snakes do not even remain with the parent. Aside from this, the evidence drawn from examination of thousands of captured snakes provides no support whatever for this yarn. There has not been one instance of a digestive tract that contained an entire litter of young snakes of the same species.

King snakes and other serpents are occasionally cannibalistic, and may eat their own kind—at least in captivity. But in this case too, no one has ever reported a litter of young in the digestive tract. The most likely explanation for the fable lies in the fact that live-bearing snakes about to give birth to their young are not infrequently killed. The young may be fully formed and quite active when, like Caesar, they are ripped untimely from their mother's womb. Although they are actually in the oviducts (the tubes that retain the eggs until they hatch), the incautious observer mistakenly believes that they must have been in the stomach. He is particularly likely to come to this conclusion if he has already heard the myth!

——Other American Colubrids. Pilot Black Snakes, *Elaphe obsoleta*, and their several relatives, the Rat Snakes, Chicken Snakes, and the handsome yellow and red Corn Snake, are among the common snakes in the eastern United States. The pilot black snake attains a greater length than the others; an unusually large specimen recorded by Conant and Bridges measured eight feet, five inches! Like the water snakes, these snakes have relatives in Europe and Asia, but none in the far West of the United States.

The Green Rat Snake, *Elaphe triaspis intermedia*, and a few other members of the genus live in Mexico, including some of the arid regions. Though they shun the deserts of the United States, the most arid regions are occupied by a close relative, the Glossy Snake, *Arizona elegans*, a burrower widely distributed from northern Mexico to California and western Nebraska.

The glossy snake comes to the surface to feed during the twilight

hours and nighttime. The pilot black snakes and rat snakes are abroad during the day, and many of them are given to climbing trees. They are all constrictors, partial to warm-blooded prey, with mice and rats as the chief victims. They also eat birds, and young opossums and rabbits have been found in the stomachs of large individuals. Birds' eggs, lizards, frogs, and other snakes are less commonly included in their diet.

THE REAR-FANGED SNAKES

The rear-fanged snakes, termed *opisthoglyphs*, are not set off in a separate family or subfamily. Some species with fangs are obviously very closely related to others that lack fangs. Located at the back of the jaw, these specialized teeth are merely grooved on the front surface—they are not tubular like those of the front-fanged species, the cobras and vipers. As a rule the snake must resort to chewing action in order to insert its rear fangs and inject venom. Such serpents prey on rather small animals—usually lizards or frogs.

We do not know why rear-fanged snakes are more abundant in the tropics than they are farther north. Relatively few of them reach the United States. The Lyre Snakes, *Trimorphodon*, which get their vernacular name from the lyre-shaped marking on the head, are represented by three species in the Southwest. The Cat-eyed Snake, *Leptodeira septentrionalis*, and the Black-banded Snake, *Coniophanes imperialis*, occur only in the extreme southern part of Texas. The Mexican Vine Snake, *Oxybelis aeneus*, a long, extraordinarily slender species mottled with gray, blends well with the twigs of the shrubs it lives in. Its range extends from Brazil to Arizona, barely north of the Mexican border.

None of these creatures is capable of producing a severe bite. The effects of the venom, though local, are sometimes painful. A much larger snake, the Boomslang, *Dispholidus typus*, found in many parts of Africa, can produce serious symptoms. Specimens exceeding five feet long are sometimes seen. Boomslangs have three sizable fangs in each upper jaw, in back of from five to seven smaller solid teeth. The fangs are close enough to the front of its mouth to be brought into action fairly readily. The boomslang feeds almost exclusively on chameleons.

One entire subfamily, the Homalopsinae, of southeastern Asia and

northern Australia, is made up of rear-fanged snakes that live in fresh water.

There are very feeble grooves in nearly all the teeth of such American serpents as the Hook-nosed Snake, *Ficimia cana,* the Spade-nosed Snake, *Chionactis occipitalis,* as well as in the Black-headed Snakes of the genus *Tantilla.* Such snakes are termed *pleuroglyphs.* All of them appear to limit their diets largely to arthropods, scorpions, spiders, centipedes, and insects.



THE CAT-EYED SNAKE

The fangs of the cat-eyed snake are placed at the back of the jaw. Merely grooved in the back, its fangs are not so readily used as the tubular fangs of cobras and vipers. The animal uses these specialized teeth mainly to kill frogs, its principal food.

In this chapter we have read mainly about snakes that are harmless, and in some cases even beneficial to man. We have seen that the generalized unreasoning terror with which these creatures are regarded has even been the genesis of myths that are sometimes fantastic, sometimes plain silly. The following chapter deals with some of the really dangerous snakes, such as the cobras, pit vipers, and rattlers.

Poisonous Snakes

THE POISON FANGS, and doubtless other parts of the venom apparatus of snakes, were perfected millions of years ago. Fossilized bones—including fangs—of a cobra that lived in France over twenty million years ago are virtually identical with those of the Egyptian Cobra, *Naja haje,* which today lives in large portions of Africa.

The cobras, like all other venomous snakes, are descended from serpents having solid front teeth. The ordinary snake's tooth is solid and recurved (curved back). Imagine such a tooth flattened out, with the edges brought together to form a tube; such is the construction of the fang. The joint may be seen on the front of the fang, with an opening at the upper end to receive the venom, and a smaller hole for its discharge above the pointed tip at the lower end. Thus the tube is lined with the same substance that forms the outside of the fang.

Actually, of course, the tubular fang is not the result of any flattening out or bending of a solid tooth. It is assumed, in the absence of a fossil record, that it evolved as a result of minor changes in successive generations over a very long period—many millions of years. The early ancestors presumably had mere grooves, possibly in several of their teeth.

In the course of time the two teeth at the front of each jaw became more specialized, and as these teeth became longer the groove in each became deeper. Eventually, in later generations, the edges of the groove came increasingly closer until they met. Once the groove was complete for the whole length of the tooth, the tubular fang came into existence—later to be copied by man when he devised the hypodermic needle.

NEW FANGS FOR OLD

The fangs, like the solid teeth, are shed from time to time. The hard substance of the fang, called dentine—is laid down in the soft gum tissue behind the socket that is to be occupied. The tip end of the fang appears first; it is then added to in somewhat the same fashion as a brick chimney is laid down. Behind each fang in use there are three replacements in progressively advanced stages of growth.

Tubular teeth at the front of the upper jaws in venomous snakes are always present in pairs, one pair on each side. One member of each pair is always solidly anchored to the jaw. The opening in the fang at the upper end of the canal is in close contact with the end of the tube or duct that leads from the venom glands located on each side of the head behind the eyes. When this fang is about to drop out, a fully-formed replacement moves forward into place in the adjacent socket. For a few days there are two fangs present in the single jaw. Then the bony substance that holds the older fang in place is resorbed (taken up and carried away by the blood). The useless fang drops out or it may be left imbedded in the prey and swallowed.

This rather elaborate mechanism for shedding and replacing fangs makes it possible for venomous snakes to keep their food-getting apparatus in excellent condition. They always have at least one usable fang on each side. During the period of growth the size of the replacement fang keeps pace with the size of the snake.

VENOM AND HOW IT WORKS

Venom glands are essentially modified salivary glands. They produce a special kind of saliva, the venom, that can cause the death of other animals when it is injected into their blood. Harmless snakes have similar glands but these produce a more or less ordinary saliva that would not produce serious effects even if they had the fangs to inject it.

Venom is an extremely complex protein compound produced by cells lining numerous small tubes inside the gland. Each tube is connected to other tubes, and not unlike the creeks flowing into a river, they discharge their venom into a main duct that leads to the base of the fang. As the fangs evolved from the simple grooved tooth to the hollow fang, it is probable that the venom became increasingly bet-

ter adapted for the purpose of killing some particular sort of prey.

Rattlesnakes feed largely upon lizards and small mammals, which their venom quickly subdues. They rarely devour other snakes, which are not seriously affected by their venom, except in very large dosages. In contrast the venom of coral snakes, which commonly feed on other snakes, promptly kills such animals. (It also kills mammals, which are not eaten.) Most venomous snakes that have been tested are essentially immune to their own venom. No one has been able to discover why some animals are relatively immune when others are not. Presumably the answers will be found in studies of the complex chemistry of living creatures.

Venom exerts its deadly effects in various ways, depending in part upon the kind of snake that produces it. The venom of many snakes contains substances that cause the blood to clot or the tissues to be destroyed. Other venoms produce their most serious effects on the nerves, which stop working when the venom reaches them, and paralysis is the result. Thus, if venom reaches the nerves that control the muscles around the lungs of a mouse that has been bitten, it will suffocate because it can no longer breathe.

It should be emphasized that venom must ordinarily reach the blood stream before it can cause any severe damage. Hungry rats have been induced to eat large amounts of fresh rattlesnake venom without showing any signs of sickness. The same amount of venom, if injected into the blood stream would have killed scores of the same animals. It is doubtful, however, whether the same rats could have eaten cobra venom. As we shall see below, the venom of cobras is quickly absorbed through the eye, and it might as easily penetrate the tissues of the mouth or digestive tract. It is obvious, however, that cobras as well as all other venomous snakes habitually swallow the animals they have killed by means of their venom. It has even been suggested that the venom, like ordinary saliva, may aid in digesting the prey.

COBRAS AND THEIR RELATIVES

The cobras and their relatives include some of the largest and most dangerous snakes in existence, making up the family Elapidae. King Cobras, *Ophiophagus hannah,* exceed all venomous snakes in length, reaching a maximum length of eighteen feet, four inches. The Black Mamba, *Dendroaspis angusticeps,* of Africa is a close second. Indi-

viduals ten or twelve feet in length are not uncommon and fourteen-footers have been reported. Some of the common cobras in Africa and Asia attain a length of more than seven feet.

The King Cobra, *Ophiophagus hannah,* because of its great size, can, when enraged, turn into an extremely ferocious and dangerous reptile. There have been many reports of unprovoked attacks on human beings by cobras. Fortunately, this cobra is not abundant, despite its extensive range throughout southeastern Asia, from peninsular India northeastward to southern China, and in the adjacent islands from the Philippines and southward through the Malay Archipelago.

The adults are usually uniformly brown or olive gray. Juveniles are black, with white, yellow, or buff cross-bars, chevron-shaped toward the front of the body. The pattern fades with increasing age, but the juvenile pattern is retained in some parts of the range until the snake has reached sizable dimensions.

——THE LIFE OF THE COBRA. King cobras generally dwell in dense jungle, but Dr. Malcolm Smith reports that in Siam they are more commonly encountered in fairly open country. The generic name (meaning "snake-eating") is indeed appropriate, for, unlike other cobras, the king cobra restricts its diet almost entirely to serpents. It devours venomous snakes as well as harmless ones. Monitor Lizards, *Varanus,* are apparently the only known exception to this fare.

The king cobra is also exceptional in that it builds a "nest." This is little more than a heap of leaves or forest debris, presumably pushed into position by sideways movements of the reptile's body. The female deposits twenty-one to forty eggs in the bottom of the nest. She remains on guard, coiled in an upper compartment completely cut off from the lower. Occasionally the male is also on hand. The young are twenty inches or so in length when they emerge.

The reports of unprovoked attacks on human beings can, in all probability, be ascribed to the fact that people have unknowingly wandered into the vicinity of a guarded nest. There can be no doubt that large king cobras are occasionally aggressive—probably as dangerous as any snake in existence. However, their usual reaction to an encounter is to make off without delay.

The Indian Cobra, *Naja naja.* Few animals are better known throughout the world than the Indian or Spectacled Cobra. When

the early Portuguese mariners visited India they returned with stories of the *cobra de capello* ("serpent of the hood"). The Portuguese name came to be so widely used that several related snakes with "hoods" have become known as "cobras."

——THE INDIAN COBRA'S TERRIFYING HOOD. Of the seven species that dwell in Africa or Asia, none stages a more magnificent performance than the Indian cobra. There are some cobras that are bigger, but few can dilate or spread the head to such an extent. The Indian cobra accomplishes this by raising and pushing forward the long ribs behind its neck. It stretches its elastic skin taut over the framework, forming a flattened area that may be almost four times as wide as the diameter of its body! The hood of some Indian cobras is ornamented with two joined eyelike markings—the "spectacle." Others have a white circle bordered with black, to form a pattern resembling a target on the back side of the hood.

Few sights are more terrifying to the uninitiated than the remarkable pose of an alarmed Indian cobra with a third or more of its body raised upright. Like the clucking and ruffling of feathers by a setting hen, or the rattle of the rattlesnake, the posture of the cobra serves the purpose of frightening the enemy. To add to the effect, the cobra generally hisses loudly when in this upright position. Furthermore, the cobra can strike from this position, inefficiently as compared with a viper to be sure, but dangerously enough.

——VENOM SPITFIRE. Far more effective when confronted by mammalian enemies is the "spitting" or ejection of venom by some cobras. This is purely a protective device, for the cobra kills its prey by biting and injecting venom. When it is confronted by what appears to be an enemy—even a human being—it sprays venom forward in two jets, one from each fang. The cobra deliberately aims for the eyes. No great accuracy is required, for at a distance of a few feet the jets break into droplets.

One drop in the eye is enough to cause immediate, excruciating pain. Unless the venom is removed immediately the structures of the eye deteriorate, resulting in permanent blindness. So rapidly is the venom absorbed through the delicate membranes that a single drop in the eye of a rat is sufficient to cause its death.

Spitting has been most often reported in the southern part of the Indian cobra's range, though, unlike two "spitters" in Africa, the Indian cobra is loath to eject its venom. Spitting, by the way, requires a

special fang. The ordinary fang directs the venom *downward* from the poison canal in the same plane as the tip. The fang of a spitter is specially adapted to direct the venom *forward,* at a right angle to the point of the fang. Interestingly enough, the same modifications appear to have evolved quite independently in the Indian cobra, with varying degrees of perfection in the different subspecies. Nonetheless, the fangs of the Black-necked Cobra, *Naja nigricollis,* and the Ringhals, *Hemachatus haemachatus,* in Africa are essentially like those of the Asiatic spitters.

——THE LIFE OF THE INDIAN COBRA. The Indian cobra is found throughout most of southern Asia, as well as in the Philippines and the Indo-Malayan Archipelago, as far east as the Celebes. It is equally at home in the jungle, in open fields, or around human habitations. It is not an aggressive snake, usually retreating when an avenue of escape is open to it. Mice, rats, frogs, toads, and—to a lesser extent—birds or other snakes are the principal elements of its diet.

The Indian cobra mates in January and February, but does not lay eggs until May or later. The parents tend to remain paired until the young hatch, one parent or the other guarding the eggs. As many as forty-five—though usually far less—are deposited in some hole in the earth. The hatchlings are ten to twelve inches long, and they more than double their length in the first year of life. By the end of four years they are nearly five feet long. This approximates the usual adult size, lengths of seven feet being rare.

The Egyptian Cobra, *Naja haje,* is famed as the imperial symbol of the Pharaoh Tutankhamen, whose tomb was discovered and excavated in 1922. This cobra is the largest of the seven species in the genus. Captain C. R. S. Pitman measured an Egyptian cobra taken near Lake Albert that was eight and a half feet long, and says that he saw even larger ones.

The Egyptian cobra, which favors warm, dry regions where water is available, is by no means confined to Egypt. It lives around the edges of the Sahara Desert, along the north coast of Africa, and southward through much of Angola and east Africa. A subspecies is found along the west coast of the Arabian Peninsula. The Egyptian cobra's hood is less spectacular than those of some other cobras.

The Black-necked or Spitting Cobra, *Naja nigricollis,* is a dangerous animal. Whether it reaches a length of seven feet is doubtful,

but its smaller size is amply compensated for by its notorious ability to eject venom. In Tanganyika Mr. Arthur Loveridge observed a black-necked cobra that spat between a dozen and twenty times—all in rapid succession. Depending on the size of the cobra, it may spray its venom a distance of six to twelve feet. In some parts of Africa dogs occasionally return from a foraging expedition partly blinded after an encounter with a spitting cobra.

Theodore Roosevelt—like many African explorers who preceded or followed him—became acquainted with these cobras during his African travels. He was fortunate in not actually meeting a cobra face to face. Others have met it, and most of them lived to regret the experience. Washing the venom from the eyes with milk is the standard remedy. Water or any nonirritating liquid would probably be equally effective, though milk may be somewhat more soothing than water.

The black-necked cobra is widely distributed in Africa, mainly south of the Sahara Desert and outside the rain-forests. It is absent from the Cape region, however. Individual snakes from western Africa are sometimes jet black. In eastern Africa one of the subspecies is brick red, except for the black bar across the region behind the throat that gives this snake its name. Cobras of the same species with a slate-gray pattern are more widespread, although in Angola one population has black and red rings alternating through the length of the body.

The Ringhals, *Hemachatus haemachatus*, the smallest of the African cobras, is also the most highly perfected spitter of them all. Fortunately for those who dwell in other areas, the ringhals is found only in the southeastern portion of the continent, especially the Cape region. It is a stout, relatively dull-colored snake, with a white bar across the underside of its body below the hood. The well-developed snout of the ringhals gives it some resemblance to the hog-nosed snake of the United States. Like the hog-nosed snake, the ringhals sometimes feigns death. But the curious observer—unless he is equipped with goggles—must beware: Close approach will invite the ejection of venom!

The ringhals, known to the Boers as the *spuw slang*, or spitting snake, erects as much of its body as the Indian cobra and displays an equally formidable-looking hood. The ringhals differs from other

cobras in having keeled (ridged) instead of smooth scales on its back. The ringhals does not lay eggs but gives birth to fully-formed young.

Other African Cobras. The Yellow Cobra, *Naja nivea,* a nonspitter confined to the Cape region of Africa, is relatively small, and appears to be more primitive than others in the genus.

The Black-lipped Cobra, *Naja melanoleuca,* one of the larger kinds, with a maximum length approaching eight feet, lives in the African rain-forests. It shares its habitat with two forest cobras, *Pseudohaje goldi* and *Pseudohaje nigra,* both of which are largely tree-dwelling. Like their Asiatic relative, the African cobras subsist on a diet of small animals, with frogs and toads probably topping the list of preferred prey.

By way of contrast, the Water Cobras, *Boulengerina annulata,* which live in some of the African lakes, are fish-eaters. These are moderately stout and large, up to six feet or more in length. Grayish in color, with black cross-bars, they bear a startling resemblance to a harmless water snake, *Cyclagras gigas,* of South America.

The Black Mamba, *Dendroaspis angusticeps.* Mambas are found only in Africa. Of five species that live in most of the continent south of the Sahara, none has a more sinister reputation than the black mamba. With the possible exception of the spitting cobras, no snake in the Dark Continent is so greatly feared. Mambas are all slender, swift-moving serpents, possibly, but not proved to be, faster than any other snake in the world. Speeds of thirty and forty miles an hour attributed to the black mamba are certainly gross exaggerations.

The fangs of the black mamba are located farther forward than in any other snake with immovable front fangs. The statement is commonly made that the fangs are exceptionally large. I could not substantiate this claim when I measured fangs and made some comparisons with cobras. In proportion to the length of the snake, the mambas have more slender but somewhat shorter fangs than the majority of cobras.

——Fact and Fancy About the Black Mamba. The yarns concerning this great snake border on the fantastic. People often endow dangerous beasts with the proportions and qualities of mythological monsters. The yarns about the black mamba are certainly no exception. "In a dusty country," according to one author, "its passage is marked by a trail of rising dust as its swiftness renders it practically

invisible." The same man later comments more cautiously that "one could obtain a true estimate of the mamba's exceptional speed by practical test, though the writer can visualize no more suicidal form of amusement than that of deliberately provoking a large mamba in order to put it through its paces!"

In Rhodesia a black mamba is said to have created a reign of terror that lasted for three years, during which time it accounted for eleven human victims. Similar stories are rampant throughout most of Africa. Most of them can be taken with several grains of salt. The black mamba may well be the deadliest snake in Africa, but it could hardly be as diabolical as it is depicted.

At all events, attacks are reported to be more frequent during the breeding season. The black mamba is known to lay eggs, though we have no reports of a "nest" like that of the king cobra. Does the mamba guard its eggs? No one can say so with assurance; but if it does, we might be able to account for the aggressive attacks made without seeming provocation. There may be truth in some of the gruesome statements about the black mamba. Others, such as that concerning the great size of the fangs, will not withstand scrutiny or investigation.

To conclude this account of the black mamba, here is another story with doubtful elements: Captain Pitman tells of a native who bore a grudge against his chief. The native tethered a black mamba near a path, knowing that the chief would use it in returning that night from a beer party. A white man discovered the dreaded reptile the following morning—too late to save the chief from the devilish intentions of his assassin.

Captain Pitman does not explain how the native managed to capture the mamba, nor how he ever succeeded in tethering it by the tail. Slender-bodied snakes usually manage to twist loose—at the expense of parting with the tail when occasion demands.

The Eastern Coral Snake, *Micrurus fulvius,* has two notable qualities. It is one of the relatively few dangerous snakes in the United States, and it is "cannibalistic," feeding on other snakes. The coral snakes are the only close relatives of the cobras in the Western Hemisphere. One of these, the Sonoran Coral Snake, *Micruroides euryxanthus,* is found in southeastern Arizona and western New Mexico in the United States, ranging down into northwestern Mexico. As for the

eastern coral snake, it is found throughout Florida and northward on the Atlantic coastal plain to North Carolina. Westward it ranges along the Gulf Coast to southern Texas and Mexico. The eastern coral snake is rarely more than a yard in length, and adults of the Sonoran coral snake average about half this size.

——Coral Snakes in Mexico. Coral snakes are much more abundant in Mexico, which has several additional species. Many more kinds are found in South America, where the maximum size is five feet. Most—but not all—coral snakes are encircled by red, yellow, and black bands. All of them are secretive burrowers, rarely encountered on the surface. Ordinarily they are not aggressive. Maximilian, the unfortunate Emperor of Mexico, is said to have carried one in his pocket without ever realizing that it was venomous.

——Coral Snakes Can Be Dangerous. There have been cases of coral snake bites with serious effects, usually as a result of the victim's handling one of these creatures. Thus, Dr. Howard K. Gloyd reports the case of a woman in Texas who was bitten by one she seized as it crossed a road at dusk. She was acquainted with the local snakes, and did not hesitate to capture one that was obviously black. To her dismay it inflicted a painful bite.

Later examination disclosed that it was a melanistic (almost entirely black) eastern coral snake; the red and yellowish bands were absent. Such abnormally marked snakes are of course the exception —as are albinos with their pink eyes and usually yellowish color. Melanism, however, is not rare in some species of snakes. And as for albinos, they may turn up in virtually any population, though they too are not commonly encountered.

The eastern coral snake feeds mostly on other snakes. Occasionally it devours lizards. As far as we know, the Sonoran coral snake preys upon the smaller burrowing snakes that dwell in the same arid region. Little is known of the breeding habits of either species, aside from the fact that the eastern coral snake lays from two to four elongate eggs.

Relatives of the Coral Snakes. In Africa, Asia, and Australia there are snakes belonging to the same family; some are also known as coral snakes. Some of them are not appreciably different from those that live in North and South America. The chances are that they have been derived quite independently from stocks within the wide-

ranging Elapidae—the cobra family. Members of this family are absent from Europe and Madagascar, though they are well represented in Africa by the cobras and mambas, and by smaller species as well.

In Australia and New Guinea, where there are no vipers or pit vipers, the dangerously venomous snakes all belong to the family Elapidae. Australia, as we know, is the only continent where the venomous snakes outnumber the harmless species. The Death Adder, *Acantophis antarcticus,* said to be responsible for most of the deaths from snake bite in Australia and New Guinea, is superficially viper-like in appearance. The Tiger Snake, *Notechis scutatus,* of Australia is also famed as a killer.

SEA SNAKES

Though all the sea snakes are venomous, they are anything but aggressive. They are probably descended from the same stock that gave rise to the cobras and their relatives. The sea snakes' mechanism for injecting venom is similar to that of the land-dwelling front-fang snakes. Sea snakes—they make up the family Hydrophiidae—feed entirely on fishes, which they pursue at any hour of the day or night. Some have a definite preference for eels.

Few sea snakes wander many miles from shore, though all of them are excellent swimmers; their flattened, paddle-shaped tails increase the effectiveness of their sinuous movements in the water. (On land they are almost helpless—unable to crawl efficiently.) When a sea snake is under water, its nostrils are closed by means of a small flap or valve, but the valves open when it comes to the surface for air. Some species are fond of basking; however, they dive and disappear upon the approach of a boat.

Like moths, sea snakes are attracted by lights. A lantern held over the water at night has often been used as a means of collecting them. Few of them bite when picked up. In New Guinea, where sea snakes ascend some of the larger rivers, fishermen occasionally find them entangled in their nets, and fearlessly throw them out by hand. Elsewhere —in China—people eat these snakes. Bathers are never attacked by sea snakes, not even the largest ones, which are sometimes eight feet long. There have been fatalities only when large sea snakes were handled carelessly.

There are two subfamilies. One is of Asiatic origin, the other has

evolved off the northern coast of Australia. Of more than fifty species, only the Common Sea Snake, *Pelamis platurus,* is widely distributed. It has crossed the Pacific and established itself along the west coast of North America, ranging as far north as Baja California. Westward this species has penetrated to the eastern coast of Africa.

Those in the more specialized subfamily, the Hydrophiinae, are strictly water-dwelling, and give birth to fully-formed young. Members of the other subfamily, the Laticaudinae, spend some time on land, where at least some of them lay their eggs. Sea snakes are also sometimes encountered in abundance off the coast of Sumatra and elsewhere. In his book *The Trail That Is Always New,* Mr. Willoughby Low describes how literally millions of these snakes assemble in a line ten feet wide and some sixty miles long! Dr. Malcolm Smith, the foremost authority on sea snakes, suggests that such assemblages may have something to do with their breeding habits, our knowledge of which is highly incomplete.

THE TRUE VIPERS

Some of the deadliest snakes in the Old World are vipers. Along with the pit vipers they have perfected the venom apparatus to a degree unsurpassed by other serpents. Each half of the upper jaw is greatly shortened and hinged to the skull in such a way that the fangs can be folded back against the roof of the mouth when at rest.

When the snake strikes, its lower jaw drops as its head is tilted backward and its fangs are swung forward. With the mouth open to an angle of almost 180 degrees, the fangs are in a nearly horizontal position. The forward part of the viper's body, which has been drawn back in sinuous curves, is straightened out at the same time that the mouth opens. This launches the head forward with considerable force, driving the fangs into the body of small prey. Some biting or chewing may follow the stabbing action.

As the fangs dig into the victim's flesh, the muscles surrounding the large glands back of the snake's head contract like a hand squeezing a syringe. This forces the venom from the spongy tissue inside the gland, driving the poison forward through the duct and the fang, into the wound.

Vipers replace their fangs in much the same way as do the cobras. The fangs of vipers are relatively longer and usually more strongly

curved back, with no suture, or joint, to mark the closure of the venom canal. The true vipers comprise the family Viperidae.

Some vipers have unbelievably long fangs. Thus, the fangs of the six-foot Gaboon Viper, *Bitis gabonica,* can penetrate to a depth of an inch and a half. If the fangs of an eighteen-foot king cobra were as large in proportion, they would be four and a half inches long! Such monsters have never existed, of course. Cobras cannot rotate their fangs to an inactive horizontal position, and this limits the size of their fangs. Consequently, as we have seen, an eighteen-foot cobra would have fangs little more than half an inch long.

THE DEADLY AFRICAN VIPERS

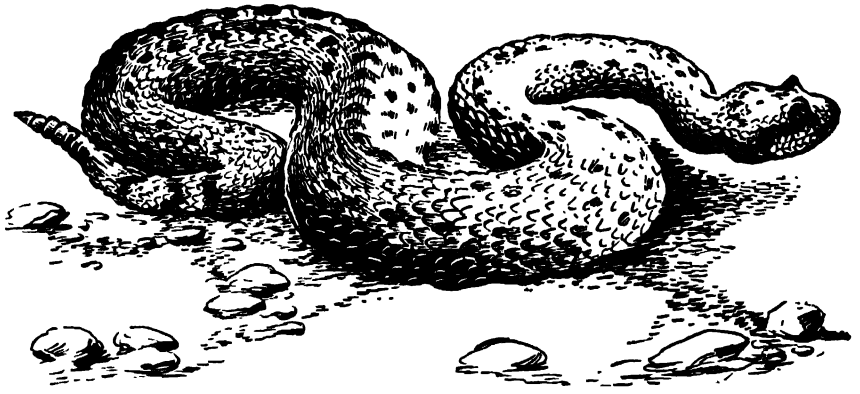
True vipers are limited to Africa, Europe, and Asia, including some of the islands in the Malay Archipelago. (They are absent from the Malay Peninsula.) They attain their greatest dimensions and diversity in Africa, where the infamous Puff Adder, *Bitis lachesis,* is quite abundant. On this continent there are prehensile-tailed vipers, *Atheris,* ground-dwellers of several genera, and also a widespread genus made up entirely of burrowers, *Atractaspis.* The latter are mostly glossy black or lead-colored snakes, with small heads not set off from the body. Some are scarcely the diameter of a pencil, and little more than a foot long. Such creatures bear little resemblance to other vipers; however, their venom apparatus clearly identifies them with the viper group. They are quick to use their fangs with telling effect on an attacker. Presumably they kill the prey with their fangs, although nothing appears to be known about their feeding habits. They come to the surface at night or, after rains, during the day.

THE "SIDEWINDING" DESERT VIPERS

In the Kalahari and Sahara Deserts of Africa and the desert regions of Asia we find a number of smaller vipers that are curiously similar to the Sidewinder, or Horned Rattlesnake, *Crotalus cerastes,* of the American deserts. None of these vipers is closely related to the rattlesnake, nor do they have rattles—rattlers are confined to the Americas. However, in their coloration, and the hornlike scale projecting over the eye, their general appearance is startlingly the same. Moreover, some of them have a specialized means of locomotion like that of the

Sidewinder. All of them are admirably adapted for moving over the barren, sandy wastes where they live.

Their method of crawling is known as "sidewinding." The name is apropos, for the snake's body does indeed move forward to one side of its head. It does not propel its body by the sinuous "swimming" movements that permit ordinary snakes to glide along, with each part of the body behind the neck region passing over the same ground. Snakes that sidewind literally roll along. The reptile raises its head from one position—with only its neck resting on the ground —and after bringing the head forward, puts it down again. The body follows, section by section, each being carried through an S-shaped path above the ground, to be rolled out on a track that continues from the neck.



THE SIDEWINDER—SNAKE OF THE DESERT

The sidewinder, or horned rattlesnake, a denizen of the American Southwest, has a special method for advancing over the sandy wastes where it dwells. In effect, sidewinding involves an S-shaped motion by the snake, and leaves "snake-prints" in the sand.

Actually, the snake's body is in contact with three tracks at the same time, being raised from one and carried to the next. As the snake rolls along on fine sand it leaves a series of perfect imprints of its body. The tracks are parallel, with a hook on the end where the tail drags, and they lie at an angle of approximately 30 degrees to the direction in which the snake is traveling.

Other sidewinding creatures are the Sahara Horned Viper, *Aspis cerastes,* and the Phoorsa, or Saw-scaled Viper, *Echis carinatus,* which lives in the deserts of both Africa and Asia. The saw-scaled viper also

resembles the American sidewinder—though it lacks the hornlike scale over the eye. The Asiatic Horned Viper, *Pseudocerastes persicus,* and the Kalahari Horned Viper, *Bitis caudalis,* probably also use the sidewinding technique; unfortunately, we lack definite reports. The most detailed studies of this method of locomotion have come from observing the only American rattlesnake that habitually sidewinds.

The Gaboon Viper, *Bitis gabonica,* has been described as "frightful-looking" and "hideous." Quite as often it has been referred to as "beautifully patterned." According to Sir Harry Johnston, the coloration of this enormous viper "is perhaps more vivid and beautiful than in any other snake. It is like a carpet pattern of alternate black, greenish yellow, mauve, and buff; while by the inflation of the body, white edges to scales are often shown."

Anyone who sees a Gaboon viper is properly impressed, regardless of whether he considers the snake handsome or repulsive. No viper surpasses it in length or weight. Pitman, who measured one five feet, eight and a half inches long in Uganda, is sure that some reach six feet. The one to which he applied the yardstick had a maximum breadth of over six inches, and the head was larger than a man's fist. The animal weighed eighteen pounds—with its stomach empty. The phenomenally large fangs have been mentioned earlier.

These gigantic vipers are largely restricted to forests, ranging over the whole of central Africa from the island of Zanzibar on the east coast to Togo on the west. The coloration of the Gaboon viper, like that of the American Copperhead, *Agkistrodon contortrix,* probably has camouflage value. The viper's head is pale brown, with two conspicuous dark bands behind each eye. Purples and browns adorn the back. Such patterns, according to Mr. Arthur Loveridge, "render this handsomely marked snake difficult to see when among leaves in a sunlit forest glade."

Despite its huge size and potentialities for danger, the Gaboon viper is not an aggressive serpent. Bites are extremely rare, even among natives, many of whom go about barelegged and barefoot.

——How the Gaboon Viper Moves. In common with its more widespread relative, the Puff Adder, *Bitis lachesis,* the Gaboon viper is a sluggish, slow-moving creature. Like other thick-bodied venomous serpents, it rarely if ever crawls by means of sinuous movements of its body. It progresses with its body straightened out, or nearly so, using

what is known as caterpillar movement, or "rectilinear locomotion." As its skin is loosely attached to the bony framework of its ribs and backbone, the snake is able to carry forward the broad scales on its belly in a series of waves. As the belly scales come in contact with the ground, they serve as a sort of anchor while the body is drawn forward within the skin. The whole action is comparable to that of a cylinder inside a flexible tube.

——THE GABOON VIPER'S PREY. The Gaboon viper preys largely on rodents, including the Giant Rat, *Cricetomys.* In the Congo Herbert Lang captured a viper of this species that contained a rail (a bird) the size of a pigeon. According to Pitman, the Gaboon viper also devours frogs. It uses its huge fangs, of course, to kill such animals, striking with lightning rapidity despite its generally sluggish movements.

The prowling activities of this viper are largely limited to the hours of darkness; like all other vipers except the burrowers and the night adders, it has eyes with elliptical pupils. Vision is probably less important to this snake than its sense of smell, though it probably employs both to some extent in trailing or locating prey.

——BREEDING IN PRODIGIOUS NUMBERS. We know astonishingly little about the reproductive habits of the Gaboon viper. There can be no doubt that it gives birth to fully-formed young—probably the practice of all vipers, with the exception of the burrowers and the Night Adders. The related puff adder, which attains a length of slightly over four feet, produces fully-formed young in prodigious numbers—as many as seventy at a time, according to report.

The Rhinoceros Viper, *Bitis nasicornis,* belongs to the same genus as the puff adder, which is the widest ranging viper in Africa and also occurs sporadically in the Arabian peninsula. The rhinoceros viper is a smaller species with quite an unusual pattern: a row of oblong blotches of blue down the back. Each blue blotch is enclosed in black, with a yellow line through the center. Down either side there extends a series of connected crimson triangles bordered with blue. Toward the belly the markings are greenish, mottled with black. A black, almost arrow-shaped patch, surrounded by blue, occupies the middle of the head, extending onto the neck. Clusters of conspicuous erectile scales above each nostril are the clue to the rhinoceros viper's name.

This snake lives in wet swampy areas in the rain-forests of central

Africa. Its habits and behavior are similar to those of its larger relatives. Smaller members of the same genus dwell in the Kalahari Desert in the southwestern portion of the continent.

The Night Adder, *Causus rhombeatus,* similar in size and proportions to the American hog-nosed snake, has much the same feeding habits, with a definite preference for toads. Its viper status appears to be primitive. It has extremely short fangs, for example, and as an adult its venom glands are not confined to its head. The glands extend backward onto its body, just under the skin, with greatly extended muscles surrounding them.

The Northern Viper or Adder, *Vipera berus,* is the only venomous snake in England. (It belongs to the genus *Vipera,* which has seven European species and is also represented in Africa.) This is a small species, few of its members exceeding two feet in length. A light zigzag pattern down the back is characteristic, though these markings may be ill defined or broken up into a series of dots. Not many people are bitten by these small European vipers; fatalities are rare. Vipers are rather abundant in some parts of England as well as on the continent. During the spring, when they come out of hibernation, groups of several individuals are sometimes encountered.

Russell's Viper, *Vipera russelli,* is the best known and most widely distributed of half a dozen vipers in Asia. A length of five feet is not uncommon, and specimens six inches longer have been reported. There are no reliable statistics, but the "Tic Polonga"—as the viper is called in India—along with the saw-scaled viper, is probably responsible for more deaths than the cobras. It has been repeatedly stated that India has twenty thousand casualties a year from the bites of venomous snakes. The source of this statement dates back three-quarters of a century and it was apparently little more than an estimate based on limited knowledge.

Fea's Viper, *Azemiops feae,* is one of the rarest snakes in collections. This snake retains some primitive characteristics, though its fangs are similar to those of the more advanced vipers. Fewer than half a dozen specimens are known; these are from upper Burma, southern China, and southwestern Tibet.

THE PIT VIPERS

Pit vipers are the most formidable snakes in the New World. They surpass Old World vipers in length and probably equal them in weight. None has fangs that approach the tremendous dimensions of the fangs of the Gaboon viper. An extraordinarily large rattlesnake eight feet long would have fangs seven-eighths of an inch in length—whereas, as we have seen, the Gaboon viper's fangs are an inch and a half long. This eight-foot monster might weigh over fifteen pounds.

Pit vipers—their family name is Crotalidae—are most widely distributed in the Americas. They are unknown in Africa, where true vipers abound, and they never reached Australia. They are relatively abundant in eastern Asia, from Korea southward. They also live in the Malay Archipelago as far south as the island of Timor. One species belonging to the same genus as the American Copperhead and Water Moccasin, *Agkistrodon,* ranges into eastern Europe, as far as the mouth of the Volga.

THE AMAZING PITS AND HOW THEY WORK

The name "pit viper" refers to the presence of a facial or loreal pit—a depression in front of, but below the level of, the eye. Its position varies somewhat in different species, but it is always present, and even more prominent than the nostril. On the mistaken assumption that the pit is a second nostril on each side, pit vipers are widely known in Latin America as *cuatro narices,* or "four nostrils."

Actually the pit is made up of two chambers, separated by a nearly transparent membrane. The forward chamber is the more obvious one. The other chamber lies behind it, with a hidden opening in front of the eye. The membrane between the two pits is richly supplied with nerve endings. Its similarity to the eardrum, which is lacking in all snakes, led to the erroneous suggestion that the pit vipers might have evolved a special hearing device on each cheek. In the absence of proof for this claim it was even suggested that such snakes had a " sixth sense"—something so foreign to human experience that we could not conceive of its use!

The experiments of Dr. G. K. Noble and A. H. Schmidt dispelled this dubious notion. In 1935 Dr. A. Ros discovered that the pits on the lips of several boas and pythons were the location of "heat re-

ceptors"—special organs used to detect the presence of warm-blooded prey. Taking their cue from Ros's paper, Noble and Schmidt tested blindfolded rattlers and discovered that, like the boas, pit vipers employed the nerve endings in the facial pits to ascertain the presence of mammals and birds. Blindfolded rattlers would strike with precision at warm objects, but seemed to be oblivious when objects of the same temperature as the surrounding air were held in front of them. They were able to detect very slight differences in temperature.

Thus, the pits are part of a highly specialized food-finding mechanism. They also enable the snake to direct the strike: Depth perception, or the ability to gauge the distance separating the snake from its warm-blooded prey, is indicated. Blindfolded Copperheads, *Agkistrodon contortrix,* will follow every movement of a warm object moved in front of them—even at distances of five or six feet, depending on the temperature of the object. They never strike at it, however, until it is sufficiently close to be reached by straightening out the body as the head is launched forward.

The venom apparatus is essentially the same as in the vipers. There are no teeth in the upper jaws except the fangs, in paired sockets to allow for replacement on each side. As in all venomous snakes, teeth are present in four additional bones in the roof of the mouth. Behind each of the facial pits there is a hollow in the side of the bone that bears the fangs. This structure and the pit itself are the only important characteristics that distinguish the vipers from the pit vipers. For this reason some authorities prefer to consider the vipers and the pit vipers as members of subfamilies.

The Bushmaster, *Lachesis muta.* Three men trudged along a trail through the dense forest of the upper Amazon. Members of a crew making a geological survey, they carried their gear in packs on their backs. Suddenly the man in the rear felt an impact as something landed on the heavy canvas of his burden. Turning, he glimpsed the coils of a snake. Yelling with fright, he hastily withdrew his arms from the straps and dropped his pack on the ground.

As he and his companions whirled around, they saw a large snake, its squirming body held by the pack, its fangs imbedded in the canvas. One member of the trio dispatched the snake with a blow from his machete. They examined the reptile and found it to be a large bushmaster, eight feet in length.

Such unprovoked attacks have given the bushmaster a reputation unequaled among American serpents. Like the king cobra in Asia and the black mamba in Africa, the largest of all the venomous snakes in the Americas occasionally strikes with fearless aggressiveness. Whether the bushmaster is truculent only when it is guarding its eggs remains to be determined. Those who have been the victim of its attack have quite understandably been concerned with other problems!

The incident just described was related to me by Dr. Harvey Bassler, who spent more than a decade in eastern Peru. During that time neither he nor his helpers had additional encounters with bushmasters. These large pit vipers turned up sporadically, and in unexpected places, but never in numbers. Of some three thousand snakes assembled by Dr. Bassler, there were fewer than a dozen of the dreaded *verrugosa,* as the snake is known in Peru.

——WHERE THE BUSHMASTER LIVES. The bushmaster is known in forested areas from Brazil and Peru northward through Colombia, the Guianas, and Panama to southern Costa Rica in Central America. It may be more abundant in some areas than in others, but it is uncommon in nearly all parts of its range. Dr. Colin Pittendrigh informs me that while he was engaged in mosquito-control work on the island of Trinidad, the bushmaster was more often seen than any other snake. However, snakes are relatively rare—or at least not often seen—in the wet lowland forests where the large pit viper lives. Hence, this statement is not to be taken to mean that bushmasters were frequently encountered.

In Trinidad the bushmaster is known as the *mapepire,* in Brazil as the *surucucú,* and in Costa Rica as the *cascabela muda.* The latter name alludes to the bushmaster's lack of a rattle—in contrast to the Cascabela, or Neotropical Rattlesnake, *Crotalus durissus.* The name *verrugosa* ("warty") refers to the bushmaster's rugose skin. The scales on its back scarcely overlap, each being topped by a keeled tubercle. The upper side of the snake is light brown or yellowish, with a series of black or dark brown saddles, each enclosing smaller light spots.

——REPRODUCTION AMONG THE BUSHMASTERS. The bushmaster differs from all other American pit vipers in that it lays eggs. It shares this trait with some of the Old World members of the same family, however. The Asiatic species, *Trimeresurus monticola* and

Agkistrodon acutus, deposit eggs and sometimes remain coiled about them.

Egg-laying is a carry-over of ancestral habits. Live-bearing in most reptiles signifies a relatively simple advance, the eggs being retained in the body until the young are fully formed. In a few reptiles (possibly in more than we realize) there is a more intimate connection with the blood of the parent. Structures approaching, though not equaling, those of the placental animals are reported for some sea snakes, the anaconda, some skinks, and night lizards (*Xantusia*). (This means that the developing embryo in such reptiles is not wholly dependent upon the food stored in the egg yolk.)

If we knew more about the bushmaster's habits and habitat, we might be able to account for its egg-laying trait. Pit vipers that carry their developing eggs often bask. The heat obtained from the sun may increase the rate of development in the embryo. For such snakes as the bushmaster that inhabit dense forests, there may be no advantage in retaining the eggs in the body. The body temperature of a snake under such conditions is unlikely to be higher than that of the earth in a habitat where no sun ever penetrates. Unfortunately such conjecture merely points to the need for additional information.

We know virtually nothing of the breeding habits of the bushmaster beyond the fact that it lays as many as a dozen eggs. Very large individuals may produce more. Eggs found in the burrows of armadillos and of the large tropical rodent known as the paca are presumed to be those of the bushmaster. Several captives have laid eggs, so that it is now certain that this is the normal method of reproduction.

We have had reports of bushmasters fourteen feet long, but this is nearly double the length of most adults. Consequently this reported maximum needs verification. Another specimen eleven feet long has also been mentioned, and Mr. R. R. Mole says that one he captured in Trinidad measured nine feet.

In captivity bushmasters have devoured rats, but more often they refuse food. Bushmasters do not thrive in captivity, and seldom live for more than a few months. They strongly resent being handled. When they are seized by the neck they often injure themselves as they lash their body about. The snake's neck is sometimes broken at the time of capture, and this further limits the number available for observation.

In comparison with rattlesnakes of comparable length, the bushmaster is a slender serpent. One from Trinidad that was slightly more than seven feet long weighed almost eight pounds. The fang of this specimen was nearly an inch long. The bushmaster is more agile in its movements than most pit vipers, but it is doubtful whether it strikes with greater rapidity than the rattlesnakes. However, those who have seen freshly captured bushmasters report that they are unbelievably quick, striking repeatedly at any moving object in their vicinity.

The Fer-de-lance, *Bothrops atrox,* owing to its wide range and abundance, is the most important venomous snake of the American tropics. It is known from Brazil and Peru northward through Central America to Mexico. North of the Isthmus of Tehuantepec in Mexico it is largely restricted to the Atlantic drainage, mainly the states of Vera Cruz, Hidalgo, San Luis Potosí, and quite possibly the southern portion of Tamaulipas. There are no definite records of this snake north of the Tropic of Cancer, however.

——THE FER-DE-LANCE HAS MANY NICKNAMES. The lance-shaped head gave rise to the name fer-de-lance, literally "iron of the lance," in the West Indian island of Martinique, where reports of this snake were spread by the French colonists. In Honduras the name *barba amarilla* ("yellow beard") refers to the yellow chin characteristic of most large members of this species. Costa Ricans use the name *toboba* for any of the venomous snakes with triangular heads, but the fer-de-lance is the "king toboba" (*toboba real*).

As with most wide-ranging species, the pattern and coloration of the fer-de-lance vary from place to place; there are further differences of detail within a region. Also there are changes that occur during the growth of an individual. Usually the adults are darker than the juveniles, often (but not invariably) with showy yellow markings. The velvety black of the skin is the source of another name, *terciopelo,* also used in Costa Rica. In parts of South America, the light X-shaped markings have resulted in the name *equis*—Spanish for the twenty-fourth letter of our alphabet.

Juveniles, which are more often seen than adults, have yellow tails. Hence the names *rabo de hueso* ("tail of bone") used in Mexico, and *rabo amarillo* ("yellow tail"), or even *rabo frito* ("fried tail"), used in parts of Central America. In Brazil adults as well as juveniles are called *jararaca.* Other names are *pelo de gato* and

toboba tiznada in Central America; *mapepire balsain* in Trinidad; and *cola blanca* and *tepotzo* in Mexico. This list—by no means complete! —points up the need for standard scientific names.

——THE STRIKE OF THE FER-DE-LANCE. Unlike many rattlesnakes, the fer-de-lance does not raise its head above the ground in order to strike. Mr. Douglas March believed it could deliver the fangs as effectively from an extended posture as it could from a coiled one. It is not essential for a venomous snake to strike in order to imbed its fangs and inject its poison. March could have vouched for this statement: he was bitten well over a dozen times by venomous snakes of different types while handling them at the Serpentarium in Honduras. He met his death as the result of a bite by a fer-de-lance.

——THE EFFECT OF THE FER-DE-LANCE'S BITE. Death does not invariably follow as the consequence of a bite from any snake. So many factors affect the situation that we must be wary of generalizing. If the snake's aim is bad, or if it strikes a bone, the fangs may glance off and inject relatively little venom. A large snake is likely to inject more venom than a smaller one. Other important factors are the victim's physical condition and his weight. Prompt first aid measures, especially incision and suction, may be of the utmost value in saving the life of a bitten person. At best, however, it is a harrowing experience.

The bite of a fer-de-lance, no matter how small, causes intense pain at the point where the venom enters the skin. This is followed by rapid swelling and discoloration. Systemic symptoms—those affecting the body as a whole—are delayed some minutes. Then a bloodstained, frothy sputum is discharged in great abundance. There are intense abdominal cramps, and a "tight" feeling develops in the chest. The victim finds it increasingly difficult to breathe. In severe cases death may ensue.

In Honduras Dr. H. C. Clark found that more people were bitten during the dry season than at other times of the year. (During this period the young of the fer-de-lance are particularly abundant.) The majority of the workers bitten were struck early in the morning during the first hour of work, usually by snakes with an empty stomach. Dr. Clark surmises that snakes unsuccessful during their hunt the previous night were still seeking food during the daylight hours.

——OTHER CREATURES PREY ON THE FER-DE-LANCE. During the daytime the fer-de-lance remains hidden. Often it selects holes in the

ground for this purpose. In Honduras accumulations of dead leaves at the base of the manaca palm provide favorite hiding places. Yet armadillos dig out snakes from such hideouts, devouring them regardless of their venomous qualities. The rear-fanged snake, *Clelia cloelia,* called the *zumbadora* in Honduras and the *mussarana* in Brazil, is known to seize an occasional fer-de-lance. Like the King Snake, *Lampropeltis getulus,* of the United States, the *zumbadora* has no particular preference for one snake over another—it takes whatever happens to be available.

The hog-nosed skunk of the American tropics has a reputation for feeding on venomous snakes, among them the fer-de-lance. The mongoose was introduced into Trinidad, St. Lucia, and Martinique with the hope of exterminating the venomous snakes. In 1930 Dr. Thomas Barbour reported the fer-de-lance to be very rare on Martinique, and he conjectured that the mongoose had helped reduce its numbers.

This belief appears to be unfounded. In 1944 the Agricultural Superintendent of St. Lucia wrote me that although the mongoose had multiplied exceedingly, there had recently been an alarming increase of the fer-de-lance in many districts. Studies of the food habits of the mongoose revealed it to be a menace to poultry and harmless native animals. Of scores of stomachs examined, not one contained the remains of a fer-de-lance!

——WHERE THE FER-DE-LANCE LIVES. The fer-de-lance is one of the serious hazards in the development of agriculture in the tropics. It dwells in woodlands, particularly in the vicinity of streams. The juveniles are likely to be tree-climbers, but the adults remain on the ground. In some areas they frequent banana or sugar cane plantations. While I was staying at the Hacienda La Oaxaqueña on the Coatzacoalcos River in southern Vera Cruz, one was killed in the yard a few feet from the house. Farther north in Mexico I found one on the Pan-American Highway in the mountains of Hidalgo. A car immediately ahead of mine ran over the snake as it was crossing the road just before midnight.

When I showed this snake to Huastecan Indians living at Palictla near the foot of the mountains, they insisted that the *rabo de hueso* was unknown in the lowlands. As the mountains receive more rain, the fer-de-lance in this region may be restricted to the uplands. In Honduras it may be largely confined to the humid regions bordering

the Atlantic, being absent from the cloud forests at higher elevations to the south.

——THE PROLIFIC FER-DE-LANCE. The fer-de-lance is an extraordinarily prolific serpent. In Honduras a captive, six feet and seven inches long, gave birth to seventy-one young on September 25, according to Douglas March. A fer-de-lance killed near the town of Progreso contained sixty-four young. Sixty-five were found in another that died in the Serpentarium at Tela in the same country. Mr. R. R. Mole reports that in Trinidad a captive gave birth to a litter, delivering three snakes on September 30, and twenty-three the following day. On October 3 there was one more birth. All but one of the twenty-seven young were born dead, probably owing to the captive parent's poor health.

Mole states that the young were nine and a half to ten inches long. Their failure to attain full size may have been due to the parent's abnormal condition. (Those born in Honduras averaged some thirteen inches in length.)

——THE SIZE OF THE ADULT FER-DE-LANCE. Among pit vipers the fer-de-lance is probably second in length to the bushmaster. Specimens longer than six feet are not uncommon in Central America, where this snake may reach greater dimensions than it does elsewhere. Ten feet has been given as the maximum, and there are rumors of twelve-footers. Whether the existence of such monsters can be proved remains to be seen; an individual much over seven feet may be considered large for a fer-de-lance. This snake is not heavy, tending to be somewhat more slender than the average rattler. The Honduran specimen six feet, seven inches long weighed a bit over four pounds after it gave birth to its huge litter. (The combined weight of the seventy-one offspring was over a pound and a half.)

——THE PREY OF THE FER-DE-LANCE. The young begin feeding soon after birth. Captive juveniles have been fed on small rodents, lizards, and small frogs. Dr. H. W. Parker of the British Museum states that a fifteen-inch specimen secured on Gorgona Island off the west coast of Colombia had eaten a centipede five and a half inches long.

Juveniles have a habit of wiggling their yellow tail, the body itself being of somber hues and not nearly so conspicuous, especially against a background of leaves in their normal habitat. The moving tail

serves as a lure, attracting small creatures to come within reach of the fangs. While feeding small frogs to young captives, Mr. Mole watched one of the frogs creep stealthily forward and seize the yellow tail in its mouth. Mr. Mole feels certain that if the young fer-de-lance had not been swallowing another frog at the moment, it would have turned and caught the frog that had seized its tail.

The tail of the adult fer-de-lance is colored like the rest of its body. When the snake is excited its tail vibrates rapidly. Despite its lack of a rattle, the sound of the tapping on the leaves or the ground produces a certain amount of noise. This behavior may have the effect of alarming the enemy, but it has nothing to do with capturing prey.

The adult fer-de-lance prowls at night, feeding on rats and other small mammals. According to Douglas March, the opossum is this snake's favorite food in northern Honduras. A fully-grown opossum was found in the stomach of a snake that measured six and a half feet. The presence of feathers in the digestive tract of another snake indicates that an occasional bird may fall victim. However, so few birds are active on the ground at night that such prey must be highly exceptional for the fer-de-lance.

——How the Pattern of the Fer-de-lance Varies. Throughout its vast range in Latin America the fer-de-lance has basically the same pattern. But elements of the pattern emphasized in one region are less noticeable on individuals from another locality. Adults from the north coast of Honduras have a series of light-edged diamond-shaped blotches on the back, with black triangular areas filling in the space between the apex of one diamond and the next. However, the lower corners of each triangle are represented by a black dot, separate from the black apex at the upper end.

The yellow-margined black triangles meeting at the center, with the two dark spots below, are particularly prominent in a specimen collected in the Mexican state of Hidalgo. The intervening diamond-shaped areas straddling the body are pale, with a pair of small oval black spots in each one. In some specimens from Nicaragua the yellow margins of the lateral triangles are quite noticeable on a dark background. Where the light margins of each triangle do not meet at the apex they stand out as series of inverted V's. Few of them run into each other across the spine to form X-shaped markings. In parts of South America the pattern of some specimens can barely be made

out—though careful inspection usually discloses traces of the V's, X's, or diamonds, depending upon which markings are best represented.

Relatives of the Fer-de-lance. Over a dozen close relatives of the fer-de-lance dwell in Mexico and Central America. More than twice that many, some of them large, live in South America. A short, stout one, *Bothrops nummifer,* called the *mano de piedra,* is rarely more than two feet in length, but it is twice as thick as a fer-de-lance of similar length. The *tamagá,* or *tamagas,* corrupted by the English to "Tommygoff" and known scientifically as *Bothrops nasuta,* is rather widely distributed in Central America, Ecuador, and Colombia. Dunn's Pit Viper, *Bothrops dunni,* lives in southern Oaxaca in the south of Mexico. Natives gathering firewood near Tehuantepec are not infrequently bitten by these small snakes, though there are few casualties. The *toboba chinga* (*Bothrops lansbergi*) is a relative to the south.

Some of the snakes in the same genus live in trees. The Eyelash Viper, *Bothrops schlegeli,* called the *bocaracá* in Costa Rica, is distinguished from others in having three scales projecting as points over the eye. These scales vary quite a bit in coloration in different areas. Some are brownish, others are green with pink cross-bars. Occasionally these snakes secrete themselves in bunches of bananas. A man was bitten in New York City by one that reached the United States in this fashion. An eyelash viper that we kept in captivity invariably held onto its prey when it struck—a habit that is probably shared by others that live in trees. If it released its fangs following a strike, a tree-dwelling snake would undoubtedly have difficulty locating its prey on the ground.

The Palm Vipers, *Bothrops nigroviridis,* are also tree dwellers, as their common name implies; but they are by no means restricted to palms. Some pit vipers living on an island off the coast of Brazil were given the name *Bothrops insularis* by the Brazilian herpetologist, Dr. Afranio do Amaral. He found them to be extraordinarily abundant in the trees, where they fed exclusively on birds. Amaral believes that drop for drop the venom of this snake is more potent than that of any other snake.

Some of the pit vipers in Asia are not unlike those in the Americas. Some also live in trees although others are ground dwellers. The Bamboo Pit Viper, *Trimeresurus gramineus,* and its near relatives

are widely distributed in eastern Asia, from southern China and Formosa to the Malay Archipelago and the Peninsula on the east to India on the West.

During World War II many American soldiers became acquainted with the Habu, *Trimeresurus flavoviridis*. This snake is fairly abundant on Okinawa, as well as some other parts of the Ryu-kyu Archipelago. It is a greenish yellow snake, with brown markings. The pattern is quite different from that of the fer-de-lance, but the body and head are startlingly similar. The habu attains a length exceeding five feet. Fully grown individuals are undoubtedly dangerous although fatalities are apparently rare.

The Water Moccasin, *Agkistrodon piscivorus,* is the largest of three species belonging to a genus restricted to North America in the New World. Individuals more than five feet long are uncommon, but Wilfred T. Neill has reported a specimen from Georgia that measured approximately five feet, nine inches. The venomous moccasin is unknown along the Atlantic Coast north of the Dismal Swamp in Virginia. Westward its range extends from peninsular Florida across the Gulf states to eastern Texas, and northward in the Mississippi valley to southern Illinois.

——THE WATER MOCCASIN'S APPEARANCE. The water moccasin's pattern consists of dark crossbands on a ground color of brown or olive. The bands vary in number from ten to fifteen, tending to be wider at the base, and darker at the center of the back. On juveniles the pattern is very noticeable. As the snake grows older the bands gradually disappear, becoming completely obscured in large individuals, which are almost uniformly slaty black.

——THE LIFE OF THE WATER MOCCASIN. The water moccasin has somewhat the same habits that we find in the more widely distributed Common Water Snake, *Natrix sipedon*. The two are frequently confused, as mentioned in our discussion of American water snakes. Moccasins are rarely found far from water. They live in swamps, bayous, and sluggish streams, often basking on the bank or on logs extending over the water. Along the edge of Payne's Prairie, south of Gainesville, Florida, they could be found in considerable numbers by overturning the piles of matted vegetation that accumulated around the edge of a shallow lake that had been drained.

On being molested the moccasin frequently stands its ground, open-

ing its mouth and vibrating its tail. This threatening gesture exposes the white lining of its mouth—the origin of the name "Cottonmouth" commonly used in the South. The moccasin is partly a water dweller and swims with a speed that is astonishing as compared with the sluggishness of its movements on land.

Moccasins prey upon an unbelievable variety of small animals. They devour fish, frogs, small lizards, mammals, and birds with equal avidity. On one of the islands in the Gulf of Mexico Dr. A. F. Carr found them waiting under heron rookeries, where they had eaten small skinks, eggshells, bits of fishbones, and other odds and ends dropped from the birds' nests.

The Mexican Moccasin, *Agkistrodon bilineatus,* ranges from Central America northward along both coasts of Mexico. In Sonora it is known as the *pichicuate,* but elsewhere it is called the *cantil.* Despite its common name, it is more like the Copperhead, *Agkistrodon contortrix,* in its habits. We know little of the Mexican moccasin's traits, but we do know that it is not restricted to the vicinity of water. A specimen from Sonora was found to have devoured a Blunt-headed Tree Snake, *Imantodes gracillimus.* The young use their yellow grub-like tail as a lure, holding it aloft and in motion.

The Copperhead, *Agkistrodon contortrix.* A very large proportion of the bites from venomous snakes in the eastern portion of the United States are inflicted by the copperhead. Fortunately it is not a large snake. Adults are usually less than a yard long, although a maximum of four feet, five inches has been reported. Fatalities are uncommon, although the copperhead is definitely a dangerous snake.

——How to Recognize the Copperhead. The copperhead gets its name from the coppery, or reddish brown coloration of its head. It is a brownish snake, with some fifteen to twenty-five darker cross-bands. There are four subspecies that grade into one another. Those in the north, from Oklahoma and Kansas eastward to Connecticut and Massachusetts, have the cross-bands constricted at the midline to form hourglass markings. Specimens from the South tend to be paler, often bordering on gray, with the cross-bands broken at the middle to form inverted V's on each side of the body.

In the area from central Texas northward through Oklahoma to southeastern Kansas, the black cross-bands are well defined, with very little constriction in the middle. The belly of this race is not conspic-

uously dark, in contrast to a population in the Davis and Chisos Mountains of western Texas, characterized by a nearly black or heavily mottled belly.

Although the copperhead is found over much of the Southeast, in the lowlands as well as the mountains to an elevation of at least four thousand feet, it is absent from peninsular Florida. Relatively few specimens have been taken in the northern part of the state.

The Common Milk Snake, *Lampropeltis doliata triangulum,* is often mistaken for the copperhead in the eastern part of the United States. The belly of the northern copperhead is usually mottled with gray or black, whereas that of the milk snake is marked with a checkerboard pattern of white and black squares. Close examination of the copperhead will disclose the facial pit, which of course is absent on the milk snake. Also, the copperhead has an elliptical catlike pupil, a characteristic that readily distinguishes it from all harmless snakes north of Virginia.

——THE COPPERHEAD'S FAVORITE HAUNTS. Copperheads are more often encountered in wooded or rocky areas. During the spring they may be abroad during the day. Hot weather usually leads them to change their habits and become nighttime creatures. By day they secrete themselves in crevices, under logs, or similar places. During the winter months they assemble in fair numbers, occasionally in the same dens occupied by the Timber Rattlesnake, *Crotalus horridus.*

Copperheads mate in the early spring, April and May, the female carrying the developing eggs inside her body throughout the summer. Dr. H. K. Gloyd found that from two to six were born in August and September in eastern Kansas. Litters of from three to ten produced in the East at the same time average a size about half again as large.

——THE COPPERHEAD'S PREY. Few other snakes are quite so versatile in their feeding habits as the copperhead. The adults devour small mammals, but young copperheads readily eat insect larvae, particularly of some of the larger moths. One found in Pennsylvania was crammed with cicadas, probably taken as they emerged from the ground. A study of the eating habits of the copperhead in Virginia disclosed its preference for mice, shrews, and caterpillars. Elsewhere skinks and other small lizards, frogs, snakes, and birds have also been recorded among the animals eaten.

THE RATTLESNAKES

Long before the arrival of Columbus the rattlesnake had left its mark on the Indian civilizations of the New World. Rattlesnakes are depicted in the art of the ancient Aztecs as well as by the primitive peoples that preceded them. Dating back perhaps nearly to the advent of man in the New World, rattlesnakes have occupied a prominent place in the mythology and religion of various groups that penetrated middle America and inevitably came to know "the serpent with the rattle."

With the possible exception of the cobras, with their spectacular upraised body and spread "hood," no snake has attracted quite such universal interest and attention. Nonetheless, the only truly distinctive character of the rattlesnake is the amazing structure on the end of its tail. As pit vipers, the rattlesnakes share many attributes with snakes found in Asia and parts of Europe. However, rattlesnakes are found only in the Americas, where one kind or another inhabits much of the territory between southern Canada and northern Argentina. Rattlesnakes belong to the genera *Crotalus* and *Sistrurus*.

HOW THE RATTLE AFFECTS ENEMIES

The rattle is a frightening device. It is not used to warn the prey, for this would interfere with the snake's food-getting activities. Neither is it a mating call; the evidence available indicates that one rattler does not hear another. It serves a purpose similar to the spreading of the hood in the cobra, or the hissing of the puff adder and bull snake, namely to distract or intimidate an enemy. The effectiveness of the rattle depends, of course, upon the ability of other animals to hear it. Rattlesnakes do not react in the same way to all enemies. They fail to rattle when approached or attacked by a king snake, for example. Under such conditions the rattler lowers its head, and arches its body, suddenly bringing it with force on the attacker as it approaches.

Weasels—and doubtless other creatures—recognize the rattlesnake as the result of the characteristic noise it can produce. Two California weasels that Dr. Raymond B. Cowles and I kept in the laboratory readily attacked and devoured lizards as well as snakes placed in

the same cage with them. They even killed and ate large bull snakes, despite their loud hissing and ferocious striking. However, when a small rattlesnake was placed before the weasels they retreated and refused to come near it. The same rattlesnake, with its rattles removed, was again placed in the cage. This time the two weasels moved in without hesitation, severing the snake's spine with dispatch, and devouring the entire carcass.

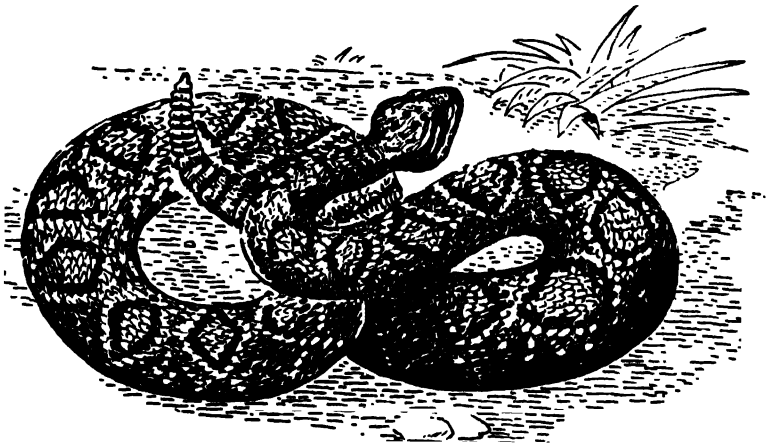
A CLOSE LOOK AT THE RATTLE

The rattle is composed of a hornlike substance exuded from a matrix at the end of the tail. It is flattened from side to side, and the segments are formed in such a way that the main axis of the string is only slightly curved when the tail is extended horizontally. However, when the tail is raised, the rattle tilts forward, there being greater freedom of movement between the segments in this direction. Those at the end of the string are lost through wear. Strings much exceeding a dozen are uncommon—seventeen is the largest number I have seen. Slightly larger strings are reliably reported. Others of phenomenal length are the result of fakery, since it is not difficult to snap several sets together. Rattlers living in rocky or brushy areas tend to have smaller strings than those inhabiting open country or some of the islands where rattlers are not often disturbed.

The rattle is made up of interlocking segments. Each impinges on the adjacent one as the tail is shaken at a rate that varies from forty-five to sixty cycles per second. The sound produced is not a rattling noise at all. On the contrary, it more nearly resembles the hiss of escaping steam—it has even been compared to the sound of bacon frying in a hot pan of grease. It may be much louder, however. A large rattlesnake can be heard at a distance of over a hundred feet. In small rattlers the noise produced is faint, resembling that of a buzzing insect.

A new segment is added to the rattle each time the skin is shed, with one exception. At birth a thickened area is present at the end of the tail. This is the pre-button, and it is lost when the skin is shed, usually within a few days after the snake has left the parent's body. This exposes the "button," a bell-shaped end on the tail. At the time of the next shedding the second segment of the rattle appears. This is composed of two lobes, one of which interlocks with the but-

ton. The next sloughing of the skin uncovers and exposes the first or forward lobe of the third segment. Behind this two other lobes interlock with the second segment. All subsequent rattles added to the string have three lobes.



THE EASTERN DIAMONDBACK—A DANGEROUS RATTLER

The eastern diamondback rattler, found in the southeastern part of the United States, is the largest of the rattlers. Two other diamondbacks inhabit the southwestern states, but neither is so large as the one in the southeast. Sometimes as many as one hundred rattlesnakes live together in one den.

The segments as they are added increase in diameter with the growth of the snake. Thus, if a string is complete, it tapers toward the button. During its first year a rattler may acquire from three to six rattles. The number depends upon the duration of the active season, and possibly the species, aside from individual variation. After they reach adult size in two and a half to three years, rattlesnakes shed their skin less frequently. Consequently fewer rattles, all of them similar in size, are added.

In California's San Joaquin Valley Dr. Henry S. Fitch made an extensive study of a population of Pacific Rattlesnakes, *Crotalus viridis,* over a period of eight years. He found that adult female rattlesnakes in that region added only one rattle per year. Males evidently shed their skin somewhat more often, for they averaged three rattles every two years.

A male ten months old that Fitch marked and liberated in Au-

gust was eighteen and a quarter inches long. It had two rattles and a button. Nearly five years and nine months later it was recaptured as an adult. It had an incomplete but tapering string of eight rattles. Comparison with other rattles indicated that about four or five had been lost. Had the string been complete the snake would have had twelve or thirteen rattles at an age of six years and two months.

WHERE RATTLESNAKES LIVE

Herpetologists recognize at least twenty-eight kinds or species; and, if we include the subspecies, we find that over sixty different names are applied to populations of rattlesnakes. There are more kinds in the American Southwest and northwestern Mexico than elsewhere. Thirteen kinds dwell in the state of Arizona alone, and as many as six of these may turn up in a single locality. (At the Humbug Gold Mine in the foothills of Yavapai County in central Arizona, Mr. William Woodin, 3rd, and I found four different kinds in a single day's collecting at one place.)

Rattlesnakes occur in every state except Maine, and possibly Delaware (where they existed, but seem to have been exterminated) in the United States. They are absent from Maine, and such parts of New York State as Long Island largely because of their extermination in these areas. Only two kinds are known in South America, a relatively large one, *Crotalus durissus terrificus*, that is widespread, and a smaller one known only from the Venezuelan highlands. A close relative is found on the tiny Dutch island of Aruba off the coast of Venezuela. The Aruba Rattlesnake, *Crotalus durissus unicolor,* is smaller and grayish white, almost without any pattern in full-grown individuals.

Between Canada and Argentina rattlesnakes have been found in a vast variety of habitats, ranging from the tropical lowlands, arid deserts and plains almost to timberline at elevations approaching eleven thousand feet in the High Sierras of California. Some prefer rocky places, others dense vegetation.

RATTLESNAKES LARGE AND SMALL

Rattlesnakes range in size from small serpents less than two feet long to monsters more than seven feet long. However, a length of over six

feet is uncommon, and an old record of the Eastern Diamond Rattler, *Crotalus adamanteus,* given as eight feet, nine inches, is unquestionably based on a stretched skin. An exceptional giant may attain eight feet—although none so large, assuming it was ever captured, has been preserved.

Rattlers six feet long are not common, even in Florida, where the maximum size of seven feet, three inches for the eastern diamond rattler is authenticated. The same species ranges northward along the Atlantic coastal plain to North Carolina. Westward along the Gulf Coast it reaches eastern Louisiana.

Throughout much of Mexico, most of Texas, parts of Oklahoma and Arkansas, and the desert regions of New Mexico, Arizona, and extreme southern California, the Desert Diamond, *Crotalus atrox,* is the largest rattler likely to be encountered. Dr. L. M. Klauber, the foremost authority on rattlesnakes, quotes Mr. W. A. King of Brownsville, Texas, who says that he measured a specimen seven feet, five inches long that weighed twenty-four pounds. Outside Texas the same species rarely reaches six feet.

Next in size are some of the tropical species. The Mexican West Coast Rattlesnake, *Crotalus basiliscus,* is found from Oaxaca to southern Sonora. Its dimensions approximate those of the desert diamond. Large individuals are by no means rare, if I may judge from the frequency with which I saw enormous tracks on the road as I drove through Nayarit and Sinaloa in 1939. Evidently this snake is active principally at night: I saw the tracks early in the morning, but never the snakes that made them.

The region from Guerrero and Tamaulipas southward to Argentina east of the Andes, is occupied by two subspecies of *Crotalus durissus.* (The Central American race, *durissus,* is somewhat larger than the South American one, *terrificus,* with which it merges in Costa Rica.) The South American species has a relatively small head as compared with that of the diamond rattlers. The maximum body size of the species is slightly under six feet. Interestingly enough, the venom of this rattler with the southernmost distribution is appreciably different from that of the North American rattlers.

Other large rattlers in the United States include the Canebrake Rattlesnake, *Crotalus horridus atricaudus,* the southern subspecies of the Timber Rattlesnake, *Crotalus horridus horridus,* that lives in most of the United States from the Mississippi valley eastward. The

Red Diamond Rattler, *Crotalus ruber,* is a large species, occasionally over five feet, that is limited to the extreme southwestern corner of California in the United States. It also dwells in nearly all of the peninsula of Baja California, where a race, *Crotalus ruber lucasensis,* at the southern extremity resembles the desert diamond.

Three species of small rattlers are referred to a separate genus, *Sistrurus,* members of which are called Ground Rattlers. They all have large symmetrically arranged plates covering the front of the head where other rattlers have numerous small scales. The largest of the group is the Massasauga, *Sistrurus catenatus,* which attains a length of nearly a yard. One of the smallest is the Carolina Ground Rattler, *Sistrurus miliarus miliarus,* which is rarely over two feet.

The smallest species in the genus *Crotalus,* and also the rarest of all rattlesnakes, is the Long-tailed Rattlesnake, *Crotalus stejnegeri.* Its range is limited to the mountains of eastern Sinaloa and western Durango in Mexico. Collectors seldom visit this region, and they may eventually find this tiny rattler to be more abundant than our present information indicates. We know of only five specimens, all of them less than two feet long.

THE PREY OF RATTLESNAKES

The larger species, particularly the diamond rattlers, prey mostly upon rabbits. In Florida the eastern diamond's favorite food is the swamp rabbit. Ground squirrels, prairie dogs, gophers, and various rodents lumped under the terms "rats" and "mice" are the chief food of adult rattlesnakes in many areas.

One of the most detailed studies of feeding habits in snakes was carried out by Dr. Henry S. Fitch. He dealt with a population of the Pacific Rattlesnake, a moderately large species with a maximum length of four and a half feet. In San Joaquin Valley, where Dr. Fitch worked, he found these rattlers to be feeding on nineteen kinds of prey. Ground squirrels topped the list, comprising well over half the food the snakes had eaten. Cottontails were second, making up nearly one-fifth of the diet. Kangaroo rats, pocket gophers, wood rats, and seven kinds of mice follow, with one chipmunk, a few lizards, three kinds of birds, and one tailless amphibian making up the remainder of the food consumed.

Elsewhere the same species of rattlesnake might have a totally

different diet. Juvenile Pacific rattlesnakes, as well as the smaller species, often kill lizards, which comprise a large proportion of their prey in some regions. Fitch estimates that an amount of food at least twice the weight of the snake is necessary to maintain it during the growing season. It is probable that most rattlers feed approximately every week or ten days during the period of the year when they are active.

MORE RATTLERS THAN WE THINK

There can be little doubt that rattlesnakes are present in greater numbers in many areas than one might expect from casual observations. Owing to their secretive habits relatively few are likely to be seen. In the area where Dr. Fitch worked, he calculated that rattlesnakes were slightly more numerous than one to the acre. Other regions undoubtedly support fewer or more, depending upon the available food supply. This in turn may be governed by competition with mammals or birds that prey upon the same rodents or other animals eaten by rattlesnakes.

Rattlesnakes that dwell in regions with cold winters often assemble in dens. The site they choose may be a natural cleft in a cliff or hillside, or it may be in the burrow or burrows of some kind of animal. On the Great Plains the rattlers often use the holes dug by prairie dogs. Rattlesnakes retire to these winter quarters in the fall, commonly in October, and do not come out until March or April. The number found in any one den depends upon many factors, including the amount of space available to house the assemblage. Often there are well over a hundred rattlers in a single den.

THE RATTLESNAKE'S ENEMIES

Despite their efficient means of defense, rattlesnakes are killed or preyed upon by a number of enemies. Human beings, of course, rarely miss an opportunity to kill a rattler. Such birds as hawks, owls, ravens, and road runners kill a few rattlers. Dr. Fitch found that red-tailed hawks and coyotes were among the more important natural enemies of the Pacific rattlesnake in the region where he studied the species. King snakes were not common in the area, but elsewhere they attack rattlesnakes—usually the smaller ones. A king snake collected

in California disgorged three juvenile rattlesnakes. The racers and other snakes also prey on small rattlers. The adults, especially of the larger rattlesnakes, are naturally far less vulnerable than the juveniles.

Some of the hoofed animals, including the pronghorn, deer, and goats are known to kill rattlers by trampling on them. An occasional horse may—the claim is often made that they do—but certainly the majority of them do not react at all to the rattlesnake. In my experience the only horses that paid the slightest attention to a rattler were those that shied at such objects as a scrap of paper carried in the breeze. On several occasions I have carried live rattlesnakes while on horseback without the horse manifesting any concern.

HOW RATTLESNAKES BREED

In the Temperate Zone most rattlesnakes mate during the spring. A few have been found paired during the fall. The young are born during the late summer or fall. The broods vary in size, there being as few as two or as many as thirty or more in a single litter. Dr. Fitch found that Pacific rattlesnakes contained from five to thirty-three eggs, not all of which may have been fertile. He believes that in this species the average litter comprises about ten. Average litter size varies from species to species.

In the United States female rattlesnakes attain the breeding size in about two and a half years. Thereafter those in the warmer regions ordinarily produce a litter every year. In the North, and possibly in the mountains farther south, litters are produced every other year. Owing to the shorter season of activity in colder regions the time required for the eggs to develop is apparently increased. A similar situation prevails among the vipers of Europe.

RATTLESNAKES ON THE MOVE

Immediately after birth, the young snakes wander extensively. They do not remain with the parent, as the myth concerning snakes swallowing their young for protection would have you believe. Adult snakes are found in greatest abundance during the early spring at the time of the mating season. They may be in search of mates, or their

movements may be partly the result of their hunger on coming out of hibernation. Juveniles are more often encountered in numbers shortly after their birth in the fall.

Dr. Fitch found that the Pacific rattlesnake had no inclination to return to a home site after being removed. On the other hand, some that he marked were found five to nine years later in the general vicinity of the place near the point of capture where they had been released. He found no evidence for any stereotyped pattern of movement, although males tended to remain within restricted areas, nearly a quarter of a mile in diameter. Females moved about less often, commonly remaining within a radius of one-sixth of a mile. Other rattlesnakes had moved distances of over a mile. Any convenient shelter was used during these wanderings—there was no sanctum that might have been called "home." It has been suggested that canebrake rattlesnakes converge to a central denning area from a radius of twenty miles. This remains to be proved.

HOW LONG DO RATTLESNAKES LIVE?

Rattlesnakes ordinarily do not thrive in captivity. Consequently we can learn little about their normal life span under captive conditions. Information obtained by marking and freeing individual snakes is far more reliable, although the time required for such experiments is usually prohibitive.

The information obtained by Dr. Fitch about the Pacific rattlesnake is better than anything available for other snakes. Dr. Fitch, as we have seen, recaptured several Pacific rattlesnakes in California that had been freed six or seven years previously. Twelve of these were old adults at the time they were first captured and marked for future identification. Most of them must have been adults for at least five or six years prior to capture. Their strings of rattles were of uniform thickness, indicating that those acquired during their early growth had already been lost. Thus, when they were found again after an interval of six or seven years, they must have been adults for at least twelve years. If about four years, the time required to reach the adult stage, be added to this figure, the twelve rattlers recaptured were at least sixteen years old. Probably many of them were much older. It is a fair guess that the life span of the oldest rattler is easily more than twenty years, and possibly thirty.

PRECAUTIONS AGAINST SNAKE BITE

Worry about snake bite is far out of proportion to the potential menace. There is no denying that scores of people are bitten annually. We lack reliable figures for the United States; estimates vary from five hundred to two thousand per year. Over an eight-year period, from 1927 to 1934, fewer than twenty-four hundred cases were actually reported. Fatalities from accidents in the home greatly exceed those from venomous snakes in the United States. It is probable that fewer than five persons in a million are bitten annually. There is greater danger of being struck by lightning than of being bitten by a venomous snake—and a better chance of survival if it is the snake that strikes. With suitable treatment the mortality from the bites of venomous snakes should be less than three out of each hundred people bitten in the United States.

Proper precautions should be taken, nevertheless. In regions infested with venomous snakes it is wise to wear long trousers or full-length boots. Going about barefooted or barelegged can be dangerous. Where the presence of venomous snakes in considerable numbers can be confirmed a suitable kit for supplying first-aid treatment ought to be available.

FIRST AID TREATMENT FOR SNAKE BITE

Prompt treatment of snake bite is essential, not only to reduce the possibility of death, but to ease the pain that usually accompanies such poisoning. Dr. Laurence M. Klauber, whose brilliant work with the rattlesnakes has made them better understood than any other group of snakes in existence, makes the following recommendations:

"Assuming that a person has actually been bitten by a rattlesnake, the following procedure should be adopted by the victim and his companions, if any be present:

"(1) The victim should not become unduly alarmed or excited, and should not run, for to do so will speed up the circulation and the rapidity with which the venom is absorbed. Remember that few cases of rattlesnake bite are fatal.

"(2) Apply a tourniquet between the bite and the heart. This may be a shoestring, necktie, or a rubber band. Rubber tubing makes

the best tourniquet. Do not tie it too tightly. Complete stoppage of the circulation is unnecessary and undesirable, but the venous flow should be impeded. Loosen the tourniquet briefly at fifteen-minute intervals.

"(3) With a sharp instrument, such as a razor blade or a knife, make a cross-incision over each fang mark, or connect the two with a single incision. The depth should be about equal to that of the fang, say a quarter of an inch if the snake is of moderate size. Before using, sterilize the cutting instrument if possible, using iodine, alcohol, or the flame of a match.

"(4) Apply suction to the wound and the incisions thus made, either with the mouth or using one of the cupping or suction devices* which have been placed in first-aid kits for this purpose. Apply this continuously for at least half an hour. In a healthy person with good teeth there need be no fear of getting venom into the mouth or stomach with untoward results.

"(5) If antivenin is available, use it in accordance with the instructions accompanying the syringe. However, do not depend upon it as a cure-all. Remember that antivenin and suction are not mutually exclusive; use antivenin if available, but the suction procedure should be carried through in any case.

"(6) If swelling or discoloration progresses up the limb, additional cross incisions should be made above this point and suction should be applied there, the tourniquet having been moved above the swelling. It is best to put on a second tourniquet before removing the first.

"(7) If the patient is faint, give a cup of strong coffee or a teaspoonful of aromatic spirits of ammonia in a glass of water.

"(8) Get the patient to a doctor or hospital as soon as possible, securing a physician experienced in previous snake-bite cases if one be available.

"(9) Do not do any of the following things: Do not use potassium permanganate. Do not give whiskey. Do not burn or cauterize the wound, since this will interfere with the all-important suction and drainage. Don't use 'folk-lore' remedies; they are a waste of time when time is valuable.

* "The rubber-bulb type is probably to be preferred since it will continue its action without an operator."

"(10) If the physician in charge of the case has not had previous experience he can secure advice from the United States Public Health Service by wire. The case should be closely watched for the first twenty-four and preferably the first forty-eight hours. Some cases have been lost because the decline in the prominent hemorrhagic symptoms (evidenced by local swelling and discoloration) seemed to indicate that the danger was past, to be followed by a sudden and unexpected onset of neurotoxic symptoms. It is suggested that physicians called upon to treat rattlesnake bite, study the publications of the United States Public Health Service, or those of Dr. Dudley Jackson of San Antonio, who has had a wide experience in this field; also the literature accompanying some of the suction devices now on the market in safety-first kits,* and the publications accompanying antivenin ampuls contain much useful information. It should be remembered, however, that these directions may be slightly biased as there has been some factional disagreement concerning the relative merits of antivenin and suction. I repeat that antivenin and suction are not mutually exclusive remedies; both should be used extensively in serious cases. The victim should always be typed so that a blood transfusion, if necessary, may be made without delay. Neurotoxic symptoms, frequently involving paralysis of the respiratory center, call for additional antivenin treatment. The physician will use intravenous injections of glucose and normal salt solution as necessitated.

"The carrying of kits containing suction devices (there are several good ones on the market) is to be recommended to campers, hunters, or others going into rattler-infested country. This is said without any desire to frighten people or to exaggerate the chance of snake bite, which is indeed remote. It is, however, a reasonable insurance precaution."

To conclude our chapters on snakes with a discussion of snake bite might leave a false impression; for, as we have seen, cases of snake bite are not many, and the number of fatal cases is very slight indeed. It is more appropriate to regard the domain of snakes with a feeling of wonder. In this world of fabulous adaptations and everyday miracles, the life of these limbless creatures unfolds with a brooding, mysterious quality that has fascinated man for countless ages.

* "The directions accompanying the Dudley First-Aid Kit are particularly complete with respect to the procedure of the suction treatment, both in the field and hospital."